EXPEDITION & WILDERNESS MEDICINE GUIDE

Presented by

WORLD EXTREME MEDICINE

FOREWORD

Never has there been so much opportunity to steer your medical skillset from prescribed career pathways towards a dynamic portfolio career which aligns with your personal and career aspirations. As I write this, we have a medical team returning from supporting Mission Impossible 8 on the ice fields of Svalbard. Additionally, we have a 12-person medical support team based for two months on a remote South Pacific Island. We also have regular trauma training teams heading into war-torn Ukraine, supporting our medical colleagues on the frontline as 'Medics4Ukraine'.

We are a world-leading training organisation preparing people like yourself to operate in remote, challenging, high-risk scenarios across expedition, extreme, humanitarian & disaster, tactical and Space Medicine. In turn, the experience gained, lessons learned, and high-performing teamwork demanded encourage self-development, which will set you apart from your peers.

We are delighted you have chosen to join us and be part of this exciting, dynamic field of study. We hope this guide, written by our senior faculty, continues your journey off the beaten track towards a future you determine for yourself. Extreme Medicine opens unimagined doors, but your tenacity and imagination will create a force for good.

I cannot wait to see the results of your work in extremes and wish you fulfilment as you embark on your journey.

PROFESSOR MARK HANNAFORD DSC (HON)

World Extreme Medicine Founder

Associate Professor in Extreme Medicine

AUTHORS

DR WILL DUFFIN

GP, Joint Medical Director for World Extreme Medicine and an academic tutor for the MSc programme in Extreme Medicine at Exeter University. Will has provided medical cover for over a dozen overseas expeditions from commercial high-altitude treks through to luxury Trans-Siberian trains to working with UNICEF in Myanmar. He is currently one of the WEM shoot doctors for the US Reality TV Show 'Survivor'.

NIKKI MCLEARY

Adventure & Human Performance Scientist, Chief Scientific Officer for World Extreme Medicine/Paramount, and Associate Editor of the BMJ Open Sports & Exercise Medicine Journal. Nikki has 25 years experience working with a multitude of demographics to bridge the gap between theory and practice in complex environments. 15 years were spent operational full-time overseas in desert, ocean and mountain locations. Her most recent role was Medical Project Lead for WEM/Paramount on Mission Impossible 8.

CONTRIBUTORS

BARRY MCKENNA - PRE-EXISTING CONDITIONS

BURJOR LANGDANA - EXPEDITION DENTISTRY

CAT BURFORD - EXPEDITION DENTISTRY

EOIN WALKER - TRAUMA

MATTHEW WALTON - COLD ENVIRONMENTS

OLLIE NEECE - COMMS

PAVANDEEP SINGH SANDU - EXPEDITION OPHTHALMOLOGY

TARYN ANDERSON - WOUNDS

CONTENTS

Expedition Planning
Medicolegal
Human Factors
Pre-Existing Medical Conditions
Extreme Environment: Hot
Extreme Environment: Cold
Extreme Environment: Tropical
Extreme Environment: Altitude
Trauma
Wounds
Water Purification
Expedition Dentistry
Mental Health
Medevac
Expedition Ophthalmology
Comms

EXPEDITION PLANNING

EXPEDITION PLANNING

"Luck is not a strategy"
UN Secretary General Antonio Guterres

Although major incidents resulting in death are rare on expedition [1] even minor field-based injuries or illness can become complicated due to the nature of the expedition, environment, participants or activity.

Comprehensive pre-expedition medical planning seeks to both mitigate risk and increase the likelihood of satisfying expedition objectives.

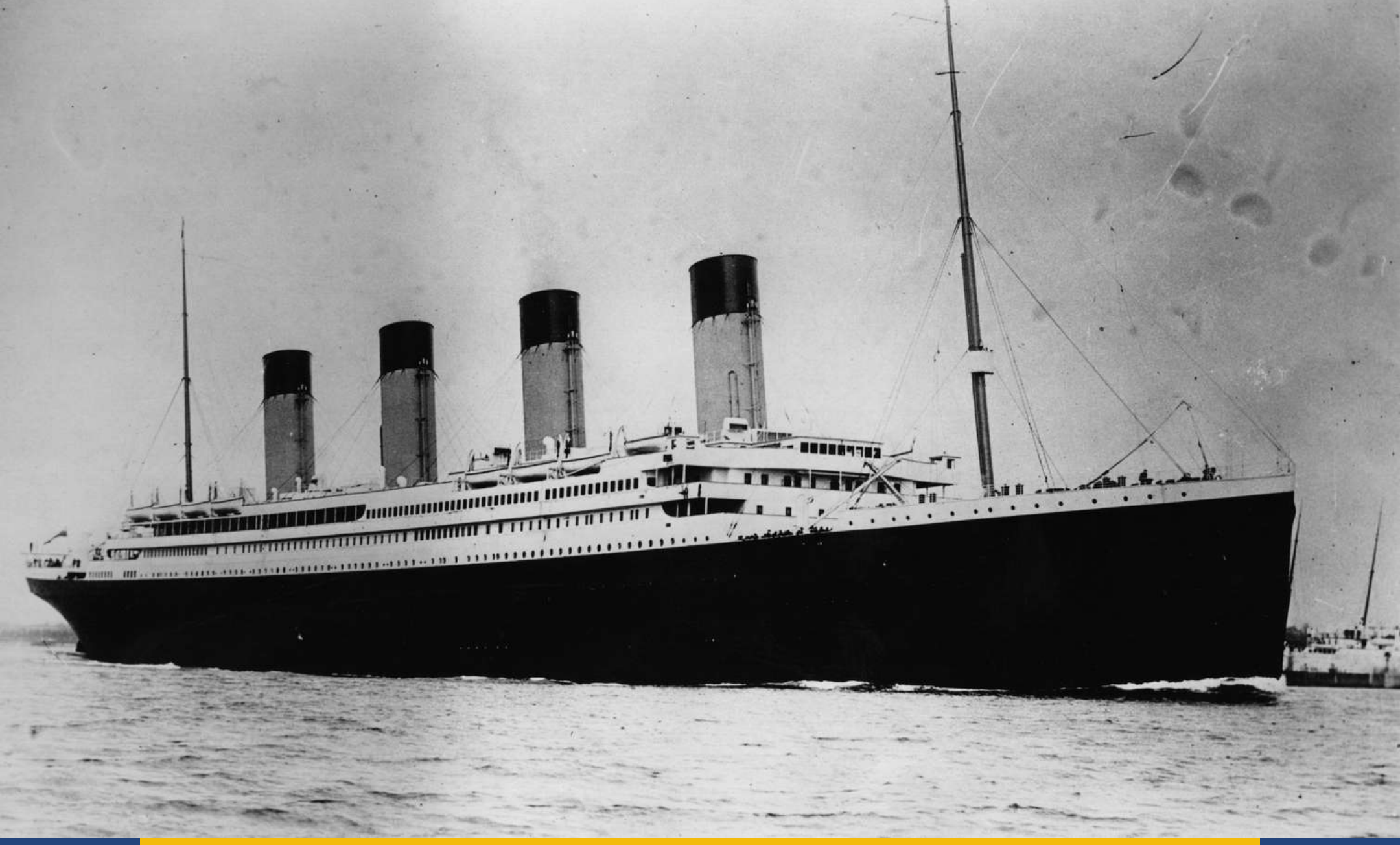
Planning is normally undertaken by the expedition organiser working collaboratively with the expedition medical officer. It is common for medical officers to join recurring expeditions or projects in which an existing plan is in place. Either way, if you are taking responsibility for the health of people in a wilderness setting, you need to know this planning has been done, scrutinise the detail and be familiar with what has been agreed.

This chapter outlines some key concepts and summarises the 10 domains of writing a pre-expedition medical planning document.

The following two examples illustrate how catastrophically things can unravel when insufficient planning coincides with unforeseen events...

TITANIC

Titanic is perhaps the most famous maritime disaster. A ship deemed unsinkable. A major contributing factor to the disaster was a lack of lifeboats. It was originally designed to carry 32 but this was reduced to 20 when it was decided a cluttered deck would ruin the views for First Class passengers. In addition, due to poor evacuation procedures, the remaining boats were grossly underfilled, leaving 1,503 people stranded as the Titanic went down.[2]



ULTRAMARATHON CHINA

In May 2022, 21 runners died in a mountain ultramarathon in Gansu, China. The competitors and organisers were caught out when severe wind, rain and hail blew in during a particularly remote and exposed section between checkpoints 2 and 3 of the 100km course.[3]

The race organisers were criticized for a lack of risk assessment and safety measures in place including the lack of a mandatory kit list. Many of the competitors were racing in the high mountains in just shorts and T-shirts with no emergency layers or shelter, which undoubtedly contributed to deaths from exposure.

ROOT CAUSE ANALYSIS (RCA)

RCA uses a systems wide approach to identify the ‘root’ problems and inherent safety hazards that have lead to a given outcome. This includes both the active errors (where humans interface with the world) and latent errors (hidden problems within the system).[4] Please see also Chapter 3 on Human Factors.

OPTIMISM BIAS

This a form of cognitive bias, that refers to the human tendency to overestimate the probability of positive events and underestimate the probability of negative events.[5] Everything has been fine up until now, so why wouldn’t things just continue this way? It is sometimes referred to as ‘the illusion of invulnerability’ [6] and is something astute expedition medical planning must guard against.

PATTERNS OF ILLNESS AND INJURIES ON EXPEDITION

A useful retrospective study examined medical reports by doctors working for Across the Divide, sister company to World Extreme Medicine, over a 4-year period (2004 – 2008).[7] During the study 210 expeditions were reviewed, ranging from sea-level to 5600m, between 3 days and 3 weeks in duration, covering 27 countries, 4 environments (desert, polar, tropical and mountainous) and 6 activities (trekking, road cycling, rafting, dog sledding, mountain biking and kayaking). The data represented 4077 participants across 1524 expedition days.

20 expeditions logged no medical incidents. The remaining 190 expeditions logged 1564 incidents classified as minor (94%) without interruption to the expedition, moderate (5%) resulting in 1 or more days absence from the expedition, or major (1%) indicating either immediate threat to life or evacuation. No deaths were reported. There was no specific analysis of medical interventions undertaken. The most commonly reported incidents were gastrointestinal upset (n=449), acute mountain sickness (n=247) which also accounted for the majority of incidents categorised as ‘major’, and musculoskeletal problems (n=146).

Singular events and expeditions have chosen to publish their own medical incident data. These present hugely variable rates and patterns of injury and illness. The level of risk involved and the injury types are very specific to each expedition. For example, the patterns of injuries involving ex-military lower-limb amputees when ascending a mountain, will be very different to those found in rowers attempting to cross the Atlantic.

BS8848

BS8848 is a widely used set of standards in the UK outdoor and adventure industry, first developed in 2007 by the British Standards Institution (BSI).[8] It was last updated in 2014. Born out of a number of tragedies that highlighted a need for better safeguards in the adventure tourism sector, it is a set of recommendations (but not legal obligations) that many providers now adhere to in order to identify themselves as BS8848 compliant. It includes some of the following criteria.[9]

- Providers should ensure reasonable access to 'medical support' and first aid, but it doesn't mandate all trips should run with medics accompanying the group
- Risk assessment and screening of participants including pre-existing conditions
- Advice on travel vaccinations
- Providers must inform leaders and participants of common risks and steps to manage them
- There should be a set of 'medical protocols' in place

Interesting fact: BS8848 is named after the height of Mount Everest above sea level in metres. However, since the inception of BS8848 Everest has grown by 1 metre to 8849 metres! This is due to shifting of the tectonic plates beneath it.

EXPEDITION MEDIC

The primary roles of an expedition medic are medical risk assessment, clinical care of the expedition members, organisation of medical kit, prescription of medication, and arranging medical evacuation.[10] However, given the medic is often viewed as part of the expedition leadership team they should also be physically fit-for-purpose and be equipped with appropriate secondary skill sets.

‘Medic’ refers to the person taking responsibility for medical care on expedition and may be an expedition leader with appropriate medical training or indeed another allied healthcare professional. We are seeing an increasing role for dentists, physios, physicians assistants, pharmacists and vets in the world of Extreme Medicine.

The Faculty of Pre-hospital Care (FPHC) provides a matrix indicating practitioner scope based on expedition risk versus number of hours from definitive care.[11] This informs the type and seniority of medic that should accompany a particular expedition. Also available is a competency framework which outlines the specific clinical skill set expected from that level.

EXPEDITION MEDICAL PLANNING DOCUMENT

While there are many ways to construct such documents, medical professionals may benefit from an evidenced-informed approach to ensure due diligence. Planning should draw on available resources including significant contribution from clinicians specialising in remote pre-hospital care, field experts familiar with the operational environment, and published research.[12]

In 2015 a panel of remote medicine and expedition specialists, including World Extreme Medicine faculty, produced guidance for medical provision for wilderness medicine. The guidance, updated in 2019 [13], continues to inform best practice for expedition medical planning.

The following 10 domains are recommended for inclusion to ensure a well-structured, comprehensive planning document:

1.OPTIMISE WORKER'S FITNESS

Understanding the participants who will undertake the expedition and preparing them adequately is paramount. The main body of the planning document allows for participant specific considerations. For example, in the case of four ex-military lower limb amputees planning to undertake an expedition to the South Pole, topics such as residual limb and prosthetic considerations, heat and the residual limb, cold and the residual limb, injury reporting trends amongst military personnel, the fitness programme schedule, and first aid training schedule need to be documented. These should be evidenced-informed, drawing from literature and experts in the field.

A pre-screening and confidential medical questionnaire can also be included under this category. A template medical questionnaire and any recommended fitness training regime can be included as an appendix in planning documents.

2.ANTICIPATE TREATABLE PROBLEMS

This involves both risk assessment and risk overview.

Generic risk assessment

Do not overcomplicate your risk assessment visually. Use Excel to create a column on the left that documents the risk, a second column which documents the preventative measures (proactive) to mitigate that risk, and a third column which documents the response measures (reactive) should that risk result in an incident. Thereafter, you can use a risk evaluation matrix (likelihood versus severity) to put the identified risks in order from very high to low documented by colour; Red very high risk, orange high risk, yellow medium risk, green low risk. You should include high-risk worse case scenario (even if highly unlikely to happen). There are plenty of worked examples of risk assessments available online.

Daily risk assessment

In addition to a generic risk assessment you may need to create a daily risk assessment to cover other activities. For example, if you are medic for a group undertaking a 7 day ski touring expedition your generic risk assessment will include everything related to this environment, activity and participant.

However, on day 4 if there is a planned 3 hour snow shoe hike you will need an additional risk assessment to take this into account.

Dynamic risk assessment

A dynamic risk assessment documents any ‘near misses’ or frequently occurring incidents (e.g. every time participants take their skis off they sling them over their shoulder without checking behind for other people). Dynamic risk assessment informs real-time and indicates where expedition protocols need to be reviewed in order to avoid the same mistakes in the future.

Risk Overview

Each risk needs to be considered from best to worse-case scenario incorporating the expedition (e.g. endurance event), environment (e.g. cold/ice/snow), activity (e.g cross-country skiing/pulk pulling/tent pitching) and participants (e.g. ex-military, lower limb amputees, female), Additionally, less obvious considerations such as dentistry, mental health, and external factors such as local road traffic incident rates etc.

Worked Example

Below is an example of how a section of content may be included within the document; Evidence-informed, referenced and succinct.

Ghoseiri et al (2014) state that prosthetics are not vapour permeable, accumulation of heat within the socket stimulates perspiration. A retrospective observational study of 38 papers revealed 53.68% of subjects experience thermal related issues due to excess moisture. The study was subject to a robust quantitative analysis and provides a good indication of potential injuries to the participants listing discomfort, friction blisters, skin irritation, skin maceration, unpleasant odour, and bacterial intrusion of the residual hair follicles.

Anecdotal evidence: Trip reports and word of mouth from previous comparable expeditions is corroborated with the above findings.

Risk frequency: considered high – long distance expedition in gruelling conditions. Cold weather reduces stump sensitivity.

Risk severity: considered moderate – significant stump problems may reduce (or even halt) progress but are unlikely to be directly limb or life threatening.

S**ubsequent risk mitigation strategy:**

1. Proactive: A recommendation is made that participants should undertake cross-country skiing for no more than 1 hour before attending to stump care. A buddy system is put in place to inspect and treat each others stumps.
2. Reactive: comprehensive padding, dressing, topical creams and other treatments of common stump problems are carried by the expedition with training on how to use.

3.STOCK APPROPRIATE MEDICATION

A full medical kit should be made available as an appendix. In a medical emergency the principles of trauma primary survey should be adhered to: D <C> Ac BCDE.

- Danger
- Catastrophic Bleeding
- Airway (with C-spine)
- Breathing
- Circulation
- Disability
- Exposure

As such, this would be a logical order to group the medical kit contents. A key point is how you are going to transport medication over borders legally or if you can buy supplies in-country. If you are crossing multiple borders you need a clear understanding around the legalities of this. When responding to a medical incident a practitioner must recognise and work within the limits of their competence.

The FPEC states the full medical list should be accompanied by a copy of the British National Formulary (BNF). In the past this involved carrying a paper copy but a digital copy may also be accessed on a mobile phone/tablet for weight saving.

4 PROVIDE ADEQUATE LOGISTICAL SUPPORT / USE QUALIFIED PROVIDERS

These sections overlap. All working partners, their credentials and protocols for the expedition should be included. If you are not organising the expedition, question if you should be part of one that does not advocate a planning document. Check the insurance policy of the organisation you are working for or with. Get their kit lists. Cross reference your findings with medical professionals who have worked for/with providers previously.

5.PROVIDE ADEQUATE MEDICAL COMMUNICATIONS

Devise a timeline for your communications. This can be submitted as part of the planning document so everyone is clear what needs to be dispatched when. Do you need to consider secondary communications if participants do not respond to the initial contact? Means of communication may be dependent on the age group you will be working with. How will you store communications so they are GDPR compliant if medically sensitive?

6. PROVIDE APPROPRIATE EQUIPMENT

This will be the responsibility of the expedition organiser and those in charge of logistics. If you are also the expedition organiser you need to outline all the kit that will be required for the expedition from clothing to field medical kit (e.g. defibrillator). In order for this to be realistic you once again need to analyse the expedition, environment, activities and participants. For example, are you going to carry a defibrillator on a remote mountain expedition which is several days from definitive care? (Usually, the answer is no). You can use this section to also highlight kit list considerations. For example, if you are taking fluids how will you stop them freezing in a cold environment? If you are taking oxygen cylinders, how can you guarantee these will stored away from combustible materials such as cooking stoves?

7. KNOWLEDGE OF THE DESTINATION

Thorough research is required around the expedition location/s. For example, where is the nearest medical facility, how would you reach this medical facility, what provisions do they have onsite, what are the geo-political considerations etc?. Local knowledge is always useful as is a pre-expedition scout of where you intend to travel if possible. UK and local foreign offices are good sources of information along with local travel agents, guides and other professionals that have operated in a similar capacity in that location previously.

8. KNOW THE ENVIRONMENT LIMITATIONS ON PATIENT ACCESS AND EVACUATION

A working knowledge of all location specific aspects, from terrain and geo-political considerations to nearest hospital and in-country rescue capabilities, needs to be outlined with any relevant contact details and integrated into a workable evacuation plan. This then needs to be condensed into an emergency response protocol laid out in the most simplistic manner possible (Spider-gram is one option) to be submitted as an appendix. Everyone on the expedition should be briefed on emergency response protocol and should know where a copy of the protocol can be found (sealed in a waterproof cover) so it can be followed if required. Plan for worse-case scenario.

9. ARRANGE KNOWLEDGEABLE AND TIMELY CONSULTATIONS

Before, during and after the expedition the practitioner is responsible for ensuring they are appropriately available to the participants. For example, does a pre-expedition medical need to take place? During the expedition are daily check-ups on each participant required? After the expedition is follow up of any clients involved in medical incidents necessary? Do you need to run outdoor first aid training for the participants? The timeline and plan for consultations needs to be documented.

10.ESTABLISH AND DISTRIBUTE RATIONAL ADMINISTRATIVE COMMUNICATION

Admin needs to be tight. Participants do not want to receive multiple communications from the medic in addition to working partners who may be dispatching information on kit lists and logistics. Everything needs to be streamlined to ensure a good experience for the participant who needs to feel the expedition is safe, professional and well-organised. The timeline and plan for admin needs to be documented.

SUMMARY

Constructing an expedition planning document is not easy without a worked example as a benchmark. Currently, acquiring such a document is difficult due to commercial sensitivity; Few if any exist in the public domain. A good rule of thumb is to write a comprehensive document that any lay person or medic could pick up and gain complete oversight of the expedition, participants and activities. 85 pages (including references and appendices) would not be an unreasonable size for a complicated expedition.

MEDICOLEGAL

Lorem ipsum dolor sit amet, consectetur adipiscing elit
Aenean nec
enim ullamcorper libero semper accumsan sit
scing a.
Quisque cursus porttitor metus vitae tincidunt. Viv
Integer blandit massa elit, ac viverra nibh iaculis s
magna, vitae luctus ante adipiscing nec. Fusce vitae
tristique, nisi vel mattis volutpat, ante nisl molestie
vulputate dolor. Cras tempus tempus nunc eget ve
hendrerit ac. Mauris quis nisi tempus, ultrices lorem sit
In eu turpis ut lectus malesuada feugiat. Suspendisse
adipiscing velit lectus, a hendrerit justo lacinia a. Praesent

MEDICOLEGAL

"Working in a remote and unfamiliar location without the diagnostic tools or support systems you usually take for granted means you have to ensure you are the right person for the job and are adequately prepared."

-Medical Protection Society

Instances of trip medics on expeditions being sued by their patients are fortunately rare. However, it is still essential that all practitioners have the correct indemnity and adhere to the same professional standards of care that they would in their usual practice back home.[1]

Part 1 of this chapter outlines what to look for in an expedition opportunity to both obtain indemnity and avoid medicolegal issues down the line.

Part 2 is a summary of some of the key principles which will be discussed in the EWM course.

SCREENING AN EXPEDITION OPPORTUNITY

Essential info about any proposed project outside your usual scope of practice that your indemnity provider will ask for:

- Duration & dates
- Destination
- Name and background of the organisation you are working for/with
- Details of your own qualifications/experience/aptitude for the trip.
- Details of the participant group (number, nationality, pre-existing conditions..)
- Financial terms: Paid work, expenses only or voluntary?
- What kit and equipment you will have access to.

This information will be passed to an underwriter to assess your suitability for the work in question, evaluate the risk of a claim being made against you and inform a yes/no decision on whether they will indemnify you.

You may be asked to pay an additional premium for this cover, usually in the form of a one-off top-up payment, typically of around a few hundred pounds, however rates are highly variable.

For UK doctors: At the point of writing, MPS and the MDU both offer case-by-case indemnity to their members for expedition work. Routinely, MDDUS does not. You are only permitted to be indemnified by one organisation at a time (i.e. MDDUS members cannot seek temporary ‘top up cover’ from the MDU or MPS).

For UK nurses: Membership of the Royal College of Nursing (RCN) includes professional indemnity insurance which can also be purchased privately through various insurance institutions worldwide. Generally, this will cover you for both medical liability and public liability. The devil is in the detail, so reading the small print and clarifying expedition details with the underwriting insurer is often required.

For UK paramedics: The College of Paramedics provides medical and public liability insurance when traveling abroad. This covers UK Paramedics practicing on their own account or delivering services through a corporate expedition entity. It is prudent to examine the T&Cs to ensure the level (financial) and scope (of practice and origin of delegates) are encompassed within the insurance.

Additional factors to help you decide if this opportunity is right for you:

- Remoteness (what is the access to local health facilities)
- Activities involved (how hazardous, what is the likelihood of injury/illness?)
- Number of medics (are you part of a team or the 'sole provider'?) The latter is clearly higher risk. If a claim is brought against you and it is felt you don't have the necessary skills/ experience you could be open to claims for clinical negligence (at least in English law)
- Reach back - who can support you clinically/operationally in the head office/back home in the event of an emergency/ medevac
- More background on the organisation you'll be working for - is it an established commercial outfit or something thrown together. What is their track record?
- Kit provision. Are they providing the med kit or are you expected to do this? (Most established outfits will have their own). Is it adequately equipped for the expedition/project?
- Medevac plan - every proposed project should have this drawn up - ask to see it or be prepared to make your own.
- Risk assessment - ask to see it
- Will you need to register with the governing health body in the host country? (Usually only required for longer deployments)

Other things to do before you step on the plane:

- What are your learning needs for this trip? Are there any areas you need to upskill on in advance that are country specific. (Think endemic disease etc). Are there any courses available that could address these?
- Are you physically fit enough? Remember you need additional reserve to take on the needs of the group and it's important you're not right 'on the edge' yourself (and no use to anyone!)
- What are the ethical and legal requirements in the host country? How do these differ to back home. (For example, in the UK health professionals have an ethical and moral duty to assist a member of the public in a medical emergency, whilst in France this is a strict legal duty).[2]

Don't forget also: Expedition Insurance

In addition to indemnity, the expedition company should provide you with travel insurance to cover the duration of the expedition, or alternatively you should take out your own personal policy that includes as a bare minimum:

- Injury/illness cover
- Cost of retrieval and repatriation

Never leave home without it!

KEY MEDICOLEGAL PRINCIPLES

To be successfully sued, a court will need to demonstrate: [3]

1. You owed a duty of care to the claimant (i.e. you were the designated medic for that group).

2.There was a breach of that duty (negligence)

3. That breached caused harm to the claimant

DUTY OF CARE

You assume a duty of care to the entire expedition party when you agree to be 'the medic'. This is a significant responsibility and is why taking on this role is not just a ticket to ride and travel to far flung places, but comes with a significant professional obligation.

Be aware the interpretation of how far this duty extends can vary from one country to the next - know before you go.

NEGLIGENCE

Negligence is the breach of a legal duty of care owed to one person by another which results in damage being caused to that person. Clinical negligence (often called medical negligence) is concerned with claims against doctors and other healthcare professionals and their employers.

Standard of Care - how should we be judged?

'*The Care provided would be judged against what could be reasonably be expected from someone with your knowledge, skills and abilities when placed in those particular circumstances*''
- Nursing and Midwifery Council Professional code of conduct.
The Bolam Test: (Bolam vs Friern Hospital 1957)[4]

“…a medical professional is not guilty of negligence if he has acted in accordance with a practice accepted as proper by a reasonable body of medical men skilled in that particular art… Putting it the other way around, a man is not negligent, if he is acting in accordance with such a practice, merely because there is a body of opinion who would take a contrary view.”

COMPETENCY

A competent individual is deemed to have the ability to apply knowledge, understanding and skills to perform to an accepted standard (Clements and Mackenzie, 2005)

Inexperience is not a defence and it's down to you to ensure you have the appropriate level of seniority for the role. This includes:

- Right professional background
- Right level of experience
- Right qualifications

Historically, competency frameworks in healthcare and in particular wilderness medicine have lacked lacked clarity and consistency.[5] This is a particular challenge when medics from a range of different professional backgrounds, including doctors, nurses, paramedics, dentists, physios and first aiders also represent the full spectrum of sub-speciality interests (there are many pathologists and ophthalmologists amongst others practicing wilderness medicine). This raises the question of how to standardise and benchmark competency.

The seminal paper 'Guidance for Medical Provision for Wilderness Medicine' (written in 2015 by WEM faculty and the Faculty of Pre Hospital Care) provides a useful framework for matching the competency level of medics with the risk level of the expedition.[6]

The authors devised the following matrix, which seeks to pair up the risk assessment of the expedition and the remoteness with an appropriate competency and experience level of medic. In these recommendations, a low risk expedition which takes places within 4 hours of definitive care should be accompanied by a non-health care professional with a recognised first aid certificate (such as an expedition leader), whereas a high risk expedition >12 hours from definitive care would mandate an 'advanced wilderness medicine practitioner' such as a senior doctor with expedition experience.

LEVEL OF EXPEDITION MEDIC RECOMMENDED

	Time 1	Time 2	Time 3
Low	D	D/G	D/G
Medium	D/G	D/G	H
High	G/H	H	H

Low	Low threat expedition
Medium	Medium threat expedition
High	High threat expedition
Time 1	<4 hours from definitive care
Time 2	4-12 hours from definitive care
Time 3	>12 hours from definitive care

- Level D—a non-health care professional with a nationally recognised first aid certificate, caring for patients as a secondary role (such as an expedition leader).
- Level G—a registered healthcare professional working in the expedition environment (such as a junior doctor, nurse or paramedic).
- Level H—an advanced wilderness medicine practitioner (such as a senior doctor with expedition experience).

RESPONSIBILITY TO LOCALS / OTHERS

"In an emergency, wherever it arises, you must offer assistance, taking account of your own safety, your competence, and the availability of others for care." - GMC Good Medical Practice

GOOD SAMARITANS ACT

Nearly all indemnity organisations will provide worldwide 'good Samaritan' cover.

This does not apply if you have agreed to take part in an expedition as the medic especially if there is any form of inducement (pay, expenses etc).

It only really applies if you are on expedition as a standard client and a genuine and unexpected emergency arises. i.e. you came across a sick patient, you were not the designated medic for that individual, and you chose to use to use your medical skills in that moment of need.

MEDICAL RECORD KEEPING

It is good practice to record every patient consultation. You may rely upon this later and it's also a useful tool when handing care over to other health professionals (in country or back to the patients' GP when they return home).[7]

Good notes = Good Defence
Poor notes = Poor Defence
No notes = No Defence

Whichever method you choose to record your consultations (paper and pen, digital notepad) ensure your notes are kept securely/password protected. Also consider the data governance of where to store your notes and how long to store them after you return from expedition.

CONFIDENTIALITY

It is vital that information sharing of sensitive medical data occurs on a need-to-know basis only, ideally with the patients' consent. It is a key part of maintaining both professional standards and trust with patients.[8]

Avoidable breeches of confidentiality, whereby sensitive information is inappropriately disclosed, commonly occur in the following circumstances:

- Other members of the expedition ask you how patient X is doing (usually out of genuine compassion) and you tell them everything without having requested the patients consent to do this.
- You are giving information over the radio and everyone in earshot hears patient information being broadcast loudly.
- Patient identifiable images and case histories are posted on social media or other platforms. Obtaining clear patient consent for this is essential.

HUMAN FACTORS

HUMAN FACTORS

The term ‘Human Factors’ could be defined as the study of who we are as human beings and how we respond to different situations. An understanding of how humans interface is a critical component for effective teams operating in complex environments. [1] A complex environment is defined as a high-risk setting with unconventional environmental, psychological and interpersonal demands. [2] It may require the performance of intricate, tightly coupled and high stakes tasks. This might be tracheal intubation of a fallen climber with serious head injury beneath a cliff face, or correctly applying a pressure-immobilisation bandage to the envenomated limb of a porter in the Peruvian Andes whilst simultaneously coordinating their medevac. Poor team performance in such environments can have severe consequences. [3]

EXAMPLE CASE

In May 1996 a group of climbers decided to summit Everest. Prior to the ascent it was pre-agreed within the team to abide by the final decision made by the team leader. The lead Sherpa, tasked with laying ropes across the most dangerous sections, was forced to drop back to aid the slowest climbers. These delays cost the group time, but they pushed on regardless, far beyond a pre-agreed turn back time. The weather deteriorated further during the descent causing some of the group to barely make it back to camp alive. Eight climbers perished on the mountain in what is now known as the 1996 Everest Disaster. Retrospective analysis of this incident revealed group members felt uncomfortable of challenging upwards when they should have done so, for fear of contradicting their own group consensus. [4] [5] Clearly, dysfunctional team dynamics and human factors had a large part to play in this tragedy and not just poor weather.

WHO AM I?

A key component of effective leadership and followership is developing self awareness: that is an appreciation of our own strengths, aptitudes, weaknesses, limitations and how we either perform (or don't perform!) under pressure. Personality profile, as informed by psychometric testing, has been found to be a reliable predictor for individual emotional response to stress which in turn directly impacts team performance. [6][7] [8]

A number of different psychometric testing tools exist to help us understand ourselves and our natural preferences better, these include:

- Myers Briggs Type Indicator (MBTI)
- Big 5
- Strength Deployment Inventory (SDI)

The Strength Deployment Inventory (SDI) is the tool we use at World Extreme Medicine.Its purpose is to analyse how you respond when placed in conflict and to facilitate the improvement of working relationships.. Understanding how others may perceive you allows an opportunity to actively consolidate your strengths and implement coping mechanisms to counter-balance your weaknesses.

Expedition medics are usually treated as part of the leadership team on an expedition. As such, they are held to the highest standards of behaviour at all times (not just in the fleeting moments they might actually be doing some medicine!). Participants require medics to show a high level of physical and psychological resilience and stability. Medics need to be in a position of strength whereby they can take on other people's problems and aren't just able to cope with their own.

RESPONDING TO DIFFERENT SITUATIONS

Individual response to environmental, psychological, physical and social demands on expedition has profound implications for physical and mental well-being. Some individuals cope well with such demands while others do not. There is limited research examining situational or day-to-day dynamics that explore why such variability exists between individuals. One piece of useful research on this topic conducted by Dr Nathan Smith,[9] explored coping mechanisms of polar explorers. The study group of professional expeditioners isn't generalisable to other demographics but nonetheless it has some useful insights. Effective coping was linked with higher-than-average measures of conscientiousness, agreeability, openness, and emotional stability. Effective coping strategies included active problem-solving and comforting self-talk. Good pre-expedition health in the form of positive mood (affect) was also found to be important.

PROBLEM AND EMOTION COPING STRATEGIES

Coping is a dynamic process with problem-focused or emotion-focused coping strategies employed as the individual feels is appropriate. A problem-focused strategy may be to put your jackets on if you know the sun is about to set and the temperature drop to avoid discomfort. An emotion-focused strategy may be to remind yourself you have chosen to be on expedition and taking each day at a time will lead to your end goal.

TEAM DYNAMICS

The Energy Investment Model, first developed by Edmonstone in 2003,[10] offers a useful framework for conceptualising the different roles that team players may adopt as a function of their attitude and energy levels. In many ways, it is an oversimplification of the complex and nuanced process that is interpersonal dynamics. However, it illustrates how team members can either work for the team or against it. Every team needs ‘players’, those who are solution rather than problem focused, get stuck in and hold the group together. These roles are not fixed, but are interchangeable. In one context a team member may perform as a player, whilst in another they may fall into the trap of becoming a victim.

THE ENERGY INVESTMENT MODEL

POSITIVE ATTITUDE	**Spectator** • Happy onlookers who enjoy the ride and don't tend to complain • Positive attitude but low group energy • Contribute when asked- compliant	**Player** • Get stuck in • Positive contribution • Positive attitude and high energy in group • Look for solutions and are generally constructive • Engaging and accepting • Can hold a group together
NEGATIVE ATTITUDE	**Victim** • Victim • Negative attitude and low group energy • Withdrawn • Victims • Feel powerless • Moaners and whingers	**Cynic** • Negative attitude, high group energy • Can be destructive • Point scorers • Like to gather allies • Resistance
	LOW ENERGY	HIGH ENERGY

BUILD A HIGH PERFORMING TEAM

High performing teams don’t just happen, they take work. Professional expeditions invest significant time and money during a long preparation phase to achieve success. Each team member works autonomously to take responsibility for themselves whilst simultaneously being aware of, and in service of, the wider needs of the group. There is a common goal, ground rules, and a sense of shared purpose. Unlocking the concept of togetherness is key to harnessing group power to achieve desired outcomes, [11] In contrast, expeditions involving members of the general public often consist of a ‘flash team’ of strangers thrown together, who are then expected to perform under challenging conditions.

COHESIVE TEAM DYNAMIC

How can you create cohesion amongst a ‘flash team’ of strangers in a short space of time? Dr Nathan Smith has some useful insights on this: [12]

1. **FITNESS**

Encourage fitness prior to the expedition and ensure there is a thorough safety brief. Expeditions are more likely to be successfully, and safely completed, when individuals amongst the group have adequate fitness and avoid illness

2. **COMMUNICATION**

Provide a means of open communication. Although negative experiences tend to be less frequently reported upon if they are left unaddressed a decline in physical and psychosocial function may evolve.

3. **UNDERSTANDING**

Help the participants understand the realities of the expedition. There are common negative themes which emerged on expedition regardless of type of setting; Fear of injury, problems with kit, concerns about weather and conditions, lack of sleep, lack of privacy, frustration and anger, boredom, homesickness, and anxiety.

PSYCHOLOGICAL NEEDS THEORY

4. Create positive expedition experiences for the group. Basic Psychological Needs Theory has been extensively researched and proposes the existence of 3 culturally-invariant, basic psychological needs (Autonomy, Competence and Relatedness). [13] Research shows that when these needs are met, subjects report improved coping processes, sleep quality, and psychological robustness under stress;

AUTONOMY

The opportunity to act independently, to have your own agency. For example, learning how to stack and ignite a fire, pitch a tent, pack kit correctly.

COMPETENCE

Feeling effective. For example, learning how to self-care for feet so blisters do not present during expedition and slow the group down.

RELATEDNESS

Feeling connected to other people. For example, undertaking a task like pitching tents that encourages a feeling of togetherness.

5.

COMMON GOALS

A group of people left to their own devices may not be aligned. By setting a series of common goals conducive to a successful expedition you can align the group in a way that achieves the 3 basic psychological needs but is practically conducive to the expedition aims at the same time. For example, split the group each night into teams and have one responsible for tents, one responsible for cooking, one responsible for clearing up etc. This alone will offer opportunity for autonomy, competence, and relatedness.

6.

KNOW YOUR PARTICIPANTS

Expeditions can target development of positive competencies such as resilience and groupwork skills, but not if the participant is so far out of their comfort zone they are constantly on edge. For example, don't expect the least experienced and most nervous member of the group to go first on that river crossing! Know your participants and gauge what level of challenge is appropriate for them.

7.

GROUND RULES

Punctuality may be less important to some participants than others but on expedition it may be the difference between connecting with a support vehicle or reaching a location before nightfall. When team members fail to perform to the expectations of the rest of the team trust reduces which can have meaningly impact where trust is important e.g. assisting in each other during a river crossing

DON'T FORGET YOURSELF!

Medics are not invincible. The responsibility of managing a group's physical and mental health on a demanding expedition may directly impact your own health. Knowing when to take time out for yourself is important. Having someone else to confide in and taking time to debrief events with other trusted members of the expedition team is essential (please see Chapter 14 on Mental Health for more detail).

PRE-EXISTING MEDICAL CONDITIONS

PRE-EXISTING MEDICAL CONDITIONS

The risks encountered by participants on a well-planned expedition is equivalent to those of an active person living in the UK [1]. ‘Well-planned’ from a medical perspective includes assessing the impact of the expedition’s physical and environmental demands on pre-existing medical conditions.

EXPEDITION RISK ASSESSMENT

The expedition medic needs to obtain a copy of the full expedition planning document with incorporated risk assessment, adding to both if required from a medical perspective (refer to Expedition Planning section). This will help inform your decision making. It’s useful to seek advice from other medical professionals with experience across the proposed expedition environment, participants and activities.

ASSESSMENT OF PRE-EXISTING MEDICAL CONDITIONS

Assessment allows you to answer the question, 'Would I be surprised if this pre-existing condition caused a medical issue, medical emergency or led to medevac during this expedition? A simple grading system is available for existing medical conditions: [3]

MILDLY AFFECTED

A well-controlled and uncomplicated condition amenable to easy self-management, e.g. mild asthma well-controlled with inhalers or high blood pressure (hypertension) with no complications

MODERATELY AFFECTED

A condition needing some medical assessment and treatment from time to time, e.g. periodic courses of steroids to control exacerbations of asthma or hypertension with known organ damage

SERIOUSLY AFFECTED

Occurrence or future risk of a life-threatening problem, e.g. recent hospitalisation for asthma or hypertension with a renal transplant on immunosuppressants

DECISION MAKING

Any decision to include/exclude prospective participants should be based on medical safety criteria and as such defendable against a claim of discrimination. If you feel it is appropriate, seek the advice and expertise of trusted clinicians within the field (participant information must be anonymised).

Decisions include:

- Participant is clearly medically fit to engage with the expedition
- Participant is clearly medically unfit to engage with the expedition
- Participant is required to optimise their underlying condition or to improve fitness before a safe participation decision can be made
- Further medical information is required from a GP or specialist (either via the participant using a provided form or by the expedition medic with signed consent)

The expedition medication/medical kit list will be informed by data collated from medical questionnaires, the expedition plan/risk assessment, and conversations with other experienced expedition medical professionals.

MEDICAL QUESTIONNAIRES

There are multiple medical questionnaire formats which can be adapted to include specifics associated with your expedition. When requesting information, it is vital to outline the following to prospective participants:

- Confidentiality of their medical information will be ensured throughout this process and will only be seen by the medic or other professionals on transfer of duty of care e.g. medevac or hospitalisation
- Participant safety is reliant on disclosure of medical conditions
- Non-disclosure of pre-existing conditions could nullify insurance and result in significant medical bills in the event of medevac or hospitalisation
- Medical Information will be securely stored, and destroyed after the expedition in accordance with GDPR
- Any medical data gathered or shared during/after the expedition will be with participant consent and anonymised

MEDICAL INFORMATION

Below are some thinking points around what needs to be considered when creating your medical questionnaire. Avoid any complicated medical jargon that is open to misinterpretation by prospective participants. Use language that encourages disclosure; You are not trying to catch people out and prevent them from participating but trying to mitigate the risks and find solutions.

IDENTITY

Alongside name, date of birth, religion etc a photo or identifying marks/tattoos reduce the likelihood of patient mis-identification

GP DETAILS/INSURER DETAILS/NEXT OF KIN

Important in event of hospitalisation or medevac

PAST MEDICAL HISTORY

- Relevant conditions e.g. past leukaemia/lymphoma impact on response to infection
- Disabilities
- Hepatitis B/C and HIV - relevance for trauma/resuscitation
- Have they had an appendicectomy?
- Fibromyalgia/ME/Chronic Fatigue Syndrome

SURGICAL HISTORY

- Emergency surgery (especially in last 6 months)
- Elective surgery (especially in last 6 months)
- Cosmetic surgery (consider trauma and rupture of breast implants)

MEDICATION

- Cross reference their medication with declared conditions
- Note any controlled drugs (implication for borders crossings)
- Note any needles (implications for flights)
- Medication impacted by dehydration (e.g. ACE inhibitors, Lithium)
- GP letter needed to carry needles on flights
- GP letter needed to carry <3 months of controlled drugs / Foreign Office letter needed to carry >3 months of controlled drugs

ALLERGIES

- Intolerance (e.g. lactose)
- Anaphylaxis to a drug (e.g. penicillin) or foodstuff (e.g. nuts). Consider the need to inform other team members to avoid sharing personal medication, alter foods, or implications for travel in Asian countries where peanut oil is used for cooking
- Rashes from common irritants and do they know the cause
- Angioedema secondary to common drugs like NSAIDs

SMOKING

- Usually measured as Pack Years (1 packet per day for 10 years is 10 years) although just consider years of smoking can give an indication of potential lung damage and impact on fitness [4].
- Can the team member carry enough cigarettes, buy them remotely for the expedition, or preferably give up in advance.

RECREATIONAL DRUGS AND ALCOHOL INTAKE

- Untreated withdrawal from alcohol or benzodiazepines can carry a mortality rate of 20-35% [5]. Assess risk and consider need to carry diazepam to treat any withdrawal

OBSTETRICS AND GYNAECOLOGY

- Knowledge of endometriosis history, contraception and/or hysterectomy can aid diagnosis of abdominal pain in females of fertility age to exclude ectopic pregnancy etc.
- Will you carry pregnancy tests?

GASTROINTESTINAL

- Consider IBS (pain, is constipation or diarrhoea predominant), steroid requirement for IBD (Crohns, UC), continence issues
- Have they had an appendicectomy?
- Stomas (how recent and well is it managed /need to carry enough stoma appliances - bags, seals, cleaning material?)

CARDIOVASCULAR

- Consider impact of recent cardiac events, e.g. MI, bypass surgery or stents as well as impact of medication e.g. ACE inhibitors and risk of acute kidney injury with dehydration or low heart rate with beta blockers.
- Will ECGs or exercise testing be needed?

ENDOCRINOLOGY

- Consider hypothyroidism treatment or important impact of Addisons disease (daily steroid requirement)

RESPIRATORY

- Asthma is the most likely condition - how well controlled, any history of ICU admission/intubation, recent oral steroids or needing steroids annually?
- COPD is in older/chronic smokers and must be carefully considered for its impact on exercise tolerance and exacerbation with altitude

NEUROLOGY AND PSYCHIATRY

- Seizures/epilepsy - frequency, triggers and medication as there may be potential drug interactions, antimalarials or antibiotics (especially erythromycin and doxycycline)
- Is there a history of psychosis, sectioning, Bipolar disorder?
- Consider implications of Lithium monitoring and dehydration complications on expedition
- Consider impact of any neurodivergence on team dynamics and travel

GENITOURINARY/RENAL

- Any history of catheterisation? Will you carry catheters?
- Any history of genital herpes? Will you carry acyclovir?

ENT (EAR, NOSE AND THROAT)

- History of otitis externa if river/sea involved on expedition
- Snoring or sleep apnoea and impact on others on expedition

OPHTHALMOLOGY

- Complications of contact lenses on expedition
- History of blepharitis or corneal ulceration

SKIN

- Consider need to prepare for eczema flares, treatment of psoriasis, recurrent abscesses, lipomas (rubbing on bergens), shingles recurrence, ulceration, burns, cellulitis as well as specialist consideration of skin interfaces for prosthetics

DENTAL

- Encourage a dental check up within six months of expedition and treatment within one month of the expedition
- Dental problems, in particular, present a potential burden to the expedition with one expedition reporting 50/309 (16.5%) of expedition members suffering dental symptoms potentially treatable with a simple dental first aid kit [6].

MUSCULOSKELETAL

- Expedition implications of past dislocations, joint replacements, amputations, knee ACL/PCL ruptures or repairs, back pain/operations, inflammatory joint problems such as Rheumatoid Arthritis or Ankylosing Spondylitis

VACCINATION HISTORY

- Ensure this fulfils the entry requirements for any expedition border crossings
- Ensure tropical disease mitigation vaccinations are up to date

ACTIONS DURING EXPEDITION

The expedition medic must ensure all participants have access to timely, confidential and conscientious consultations to monitor and treat pre-existing conditions. This should be documented for medicolegal reasons or in event of medevac or hospitalisation. You should keep 1 copy in a digitally secure format that continues to be GDPR compliant post-expedition.

Using this guidance, the conscientious medic can elucidate the risks specific to the planned expedition before obtaining comprehensive medical information relevant to each participant. The timeline should be sufficient to allow informed decisions on inclusion, exclusion or optimisation of participants based on their pre existing conditions as well as a plan for appropriate stocking of medication and monitoring of these conditions during the expedition.

EXTREME ENVIRONMENTS: HOT

HOT MEDICINE

Currently between 14% and 20% of the earth's surface is covered by hot deserts, although this is likely to expand over the forthcoming century due to global warming, poor land management and overgrazing. [1]

Aridity is a defining characteristic of a desert; According to the Koppen-Geiger climate classification an annual precipitation of less than 250 mm is experienced.[2] Only 15 – 20% of deserts are covered by sand dunes, the remaining terrain consists of mountain plateaus, tundra and rocky terrain.

While hot deserts host a range of flora and fauna, they can be one of the earth's harshest environments. A characteristic feature of deserts is massive swings in temperature from day to night (ranging from 40°C+ to below 0°C). Such temperature shifts can generate high wind energy. [1] Other hazards include disorientating terrain, water scarcity and venomous terrestrials.

Interesting fact: not all deserts are hot. The largest desert on earth is actually 13.8 million square kilometres in size: the wild expanse of ice that makes up Antarctica. It receives a yearly average rainfall of just 10mm.[3]

HEAT STRESS

Heat stress is the most obvious immediate environmental risk given the body can only tolerate minor elevations in core temperature. There are a range of mechanisms through which the body can lose heat (see the chapter on ‘Cold’) and these can be exploited to cool a casualty who has been exposed.

A range of physiological responses are evoked by heat exposure. The response to heat is predictable and mostly preventable.[4] A key part of expedition and event planning is anticipating the degree of heat stress. Heat Index (HI) measures this through two key factors: temperature and humidity. The most comprehensive tool to predict heat stress however is The Wet Bulb Globe Temperature (WBGT). This takes into account five factors including air temperature, sun angle, cloud cover, humidity and wind speed. It requires specialist equipment consisting of a bulb covered by a water soaked cloth.[5] Whilst these devices are commonly deployed in commercial sectors and the military, it is rare for them to appear in conventional expeditions.

Exertional Heat Illness (EHI) is a real danger when performing intense exercise such as trekking or running in hot deserts. Dehydration complicates the challenges around heat dissipation; For every 1% of body mass lost through dehydration there appears to be an increase in core temperature of 0.22°C [6]

RISK FACTORS FOR HEAT STRESS

ENVIRONMENTAL FACTORS

- High ambient temperature and humidity with lack of cooling wind (high heat index)
- Overexertion, low work efficiency, lack of rest

PATIENT FACTORS

- Lack of heat acclimatisation
- Low physical fitness
- Chronic illness (diabetes, heart disease)
- Reduced skin area to mass ratio (e.g obesity)
- Intercurrent Viral or bacterial infection (i.e. diarrhoeal illness)
- Dehydration
- Caffeine and alcohol
- Stimulant drugs (amphetamines, cocaine)
- Medications including calcium channel blockers, ace inhibitors and SSRI's.

HEAT ILLNESS

Disorders of hyperthermia present on a continuum from benign conditions such as heat rash to severe life-threatening conditions such as heatstroke. Characterised by dysregulation of the body's thermoregulation capacity, early recognition and treatment of heat illness is vital to prevent escalation. This can be particularly difficult during competitive sport or expedition where the athlete may be driven to press on.[7] [8]

HEAT RASH

Caused by obstructed eccrine sweat glands there are 3 types. [9]

MILIARIA CRYSTALLINA	the most common, typically presenting as clear vesicles on the face and trunk. Obstructive clothing/material may exacerbate the condition.
MILIARIA RUBRA	involves the deeper epidermis normally presenting on the neck and trunk. It typically emerges days or weeks after heat exposure.
MILIARIA PUSTULOSA	present as larger white vesicles formed within the deeper, dermal-epidermal layers.

HEAT CRAMPS

Caused by a deficiency of sodium, potassium, chloride, or magnesium. Presenting as involuntary spasmodic contractions of large muscle groups, in contrast to isolated muscle cramping caused by exertion. Regardless, both have the same treatment approach, ,which is rest, fluids and electrolytes by mouth and sometimes stretching out the affected limb.

HEAT OEDEMA

Usually presents as ankle +/- hands swelling in first few days of entering a hot environment. Normally self resolves. [7]

HEAT SYNCOPE

Thought to be caused by decreased cerebral blood flood resulting from a combination of dehydration, blood pooling in the venous system, reduced cardiac filling and low blood pressure. Prolonged standing or positional adjustments in hot temperatures can cause self-limiting dizziness, weakness and loss of consciousness.[7]

HEAT EXHAUSTION

Where the patient's cardiac output cannot meet the demands of increased blood flow to skin, muscles and vital organs compounded by dehydration and salt loss from sweating. It presents as any combination of headache (most common), exhaustion (most common), nausea, vomiting, dizziness, irritability, weakness, fainting, muscle cramps, excessive sweating, thirst and decreased urine output. Whilst there is no organ failure (yet), immediate action is required to prevent progression to life-threatening heat stroke (see below).

HEAT STROKE

Similar symptomatology to heat exhaustion but a key difference is a cessation of sweating resulting in red, hot dry skin progressing to a systemic inflammatory response (SIRS) which manifests as CNS dysfunction (confusion, coma) and cardiovascular collapse. Core temperature is >40 degrees C, but this is often not measured in practice and the diagnosis is usually based on other clinical features. This is a life-threatening emergency and requires rapid cooling. [7]

SUNBURN

Commonly associated with heat exhaustion and heat stroke, but not technically categorised as a heat illness as it is due to direct sunlight exposure rather than a rise in core body temperature.

TREATMENT OF HEAT EXHAUSTION & HEAT STROKE

- Full ABCDE assessment
- Shade (reduce suns radiant heat)
- Expose patient and douse in cold water and ice cubes (evaporative and conductive cooling). Immerse in body of cold water if safe and feasible to do so.
- Fanning (convective cooling)
- Rehydration with oral or IV fluids
- Evacuation

In high humidity (relative humidity >75%) evaporative cooling becomes ineffective. [9]

EXTREME ENVIRONMENTS: COLD

COLD MEDICINE

Maintenance of core temperature is essential for organs to operate proficiently on a cellular level. In an ambient air temperature of 20°C to 25°C, an otherwise healthy, unclothed individual is able to easily maintain a core temperature of approximately 37°C without expending additional energy.[1] In more extreme non-thermoneutral environments, human can thermoregulate within certain parameters (approximately 12°C - 54°C) for variable periods. These time periods can be extended through equipment and clothing (down jackets, shelter, heat-generating devices).[2]

HEAT LOSS

Heat loss occurs through 5 mechanisms; [1]

1. Radiation (heat loss to the surrounding environment)
2. Convection (loss to wind chill)
3. Conduction (direct contact with objects such as metal)
4. Evaporation (heat loss through perspiration and wet kit)
5. Respiration (heat and vapour loss when breathing)

A high risk environment is one that exposes humans to low ambient air temperature, high winds, or altitude (air temperature decreases by approximately 6.5°C every 1000 metres height gain).[3]

To counterbalance heat loss the body evokes two responses;

1. Peripheral vasoconstriction to inhibit heat loss, and
2. Shivering to replace lost heat through thermogenesis. [4]

If heat loss exceeds heat retention cold injury may occur.

WHOLE BODY COOLING (HYPOTHERMIA)

Occurs when the core temperature drops below approximately 35°C.

PART BODY COOLING (FREEZING COLD & NON-FREEZING COLD INJURY)

Mainly impacts the peripherals.

FREEZING COLD INJURY (FCI)

Includes Frostnip and Frostbite and is defined as damage sustained by tissue exposed to temperatures below their freezing point (-0.55°C).

NON-FREEZING COLD INJURY (NFCI)

Includes Chilblains and Trench Foot, is defined as tissue exposed to low temperatures between 0°C - 15°C for hours or days. [5] [6]

RISK FACTORS FOR COLD INJURY [7]

ENVIRONMENTAL FACTORS:

- Low ambient air temperature, high wind chill, damp or inadequate clothing. [1]
- Static casualty (i.e. injured and unable to move, not generating body heat)

PATIENT FACTORS:

- Poor nutrition
- Dehydration
- Alcohol
- Medical conditions (i.e. Raynauds)

Treatment of cold injury may be delayed due to the nature of an expedition, environment, activity or participant.

EXAMPLE CASE

During the 2022 Winter Olympics, the men's 50km mass start cross country race was shortened to 30km due to the still air temperature of -25°C (-32°C with wind chill). In spite of this mitigation measure the athlete placing 28th suffered frostbite to his penis. He had suffered the same injury in a previous race and was therefore more susceptible to re-injury.

COLD INJURIES [8]

HYPOTHERMIA

Behaviour is a key indicator of hypothermia in a pre-hospital setting due to the challenges of determining an exact body temperature. The well described behavioural changes below are colloquially referred to as the ‘umbles’:

STUMBLES	loss of control over movements, slowed motion, stiffness in extremes
MUMBLES	slurred or slow or incoherent speech, sleepiness, confusion
FUMBLES	slow reaction time, dropping objects, poor co-ordination
GRUMBLES	change in behaviour, expressing a negative attitude, paradoxical undressing
CRUMBLES	life threatening, inability to walk, consciousness decreasing, decreased heart/respiratory rate, cardiac arrest

FREEZING COLD INJURY (FCI)

Frostnip is a superficial injury to exposed skin caused by intense vasoconstriction (commonly cheek, ears and nose). Presentation of frost nip suggests suitable environmental conditions for frost bite. [8] Area numb, looks like pale wax dropped on skin.

FROSTBITE

Hypothermia and frostbite often co-present. Moderate to severe hypothermia should be addressed first. Thereafter, the medical professional must make a decision to rewarm and thaw or leave the affected body part frozen. If there is a risk of refreezing after thawing, then it is generally considered better to delay rewarming. The severity of frostbite is determined by a 2-tier system; superficial (1st and 2nd degree) or deep (3rd or 4th degree). [8] Frost bite presents as numb & pale skin with a woody appearance (covering socks or gloves may themselves be frozen). Large areas may go purple from blood sludging. [9]

NON-FREEZING COLD INJURY (NFCI)

Chilblains are localised legions presenting mainly in susceptible individuals (e.g Raynauds) after prolonged exposure to cold then heat (e.g cold feet on hot radiator). [9] Trench foot is caused by sustained cold and non-freezing cold conditions (e.g skiing in damp socks). [10]

POLAR THIGH

Appears to present in polar regions due to mechanical abrasion coupled with cold and/or wind chill conditions. It most commonly presents on the anterior thigh but has also been reported on the medial/posterior thigh. [11]

IATROGENIC HYPOTHERMIA

Awareness of the cold environment is paramount when treating a casualty for other unrelated injuries or illness. Inflicting accidental hypothermia needs to be avoided. Beware of the risk of evolving hypothermia in the wider group once you are all standing still and no longer moving, this includes yourself.

A NOTE ON PEOPLE WITH AMPUTATIONS

Several polar expeditions have been undertaken by ex-military amputees in the past decade. A lack of sensation in the amputated area appears to inhibit acknowledgement of cold injury. Research around stump injury diagnosis and management is limited.

HYPOTHERMIA MANAGEMENT

STAGE 1:

Mentally alert and shivering = mild hypothermia

PASSIVE REWARMING

- Remove from the cold environment
- Remove wet clothing
- Add a vapor barrier
- Wrap like a burrito (sleeping bag)
- Insulate from ground (roll mats, rucksacks)
- Sugar, warm drink, hydrate

AVOID:

Alcohol = vasodilator,
Caffeine = Diuretic
Nicotine = Vasoconstrictor

‘Hunter’s response’ = Evolutionary adaptation in which the body periodically (every 5-10 mins) vasodilates and constricts hands & feet to balance hypothermia & cold injury.[10]

HYPOTHERMIA MANAGEMENT

STAGE 2:

Reduced consciousness and alertness waning
= moderate to severe hypothermia [6]

ACTIVE EXTERNAL REWARMING

- Bear hugger
- Heat packs, lamps, warm bath

Need for continuous monitoring – peripheral cool blood returning to core can worsen hypothermia during re-warming process (- 1.5°C)

ACTIVE CORE REWARMING

- Warm IV Fluids and Oxygen (44°C)
- Cavity lavage (reserved for cardiac arrest, frozen limb or failed conservative)
- ECMO (pH >6.5, potassium <10mmol/L, core >12°C)

PATIENTS WITH HYPOTHERMIA ARE NOT DEAD UNTIL THEY ARE WARM AND DEAD

Patients may appear dead: Pulseless at radials, HR = 3, RR = 1, Pupils dilated, no corneal reflex. However, Oxygen consumption is significantly reduced and hypothermia is neuroprotective. There are numerous case reports of extreme survival, including a case of neurologically intact survival 2 year old boy presenting with a core body temperature of 11.8 degrees C. [11]

HANDLE LIKE PORCELAIN

It is important to handle unconscious and not shivering patients with care. VF arrest can be triggered by movement!

ADVANCED LIFE SUPPORT

- 1 minute pulse and respiratory effort check. If in doubt, start CPR
- CPR futile if non-compressible chest (whole body frozen) or prolonged avalanche burial with snow in airways
- Consider a mechanical compression device to overcome chest stiffness
- Defibrillate 3x below 30°C but no more until >30°C. Use oesophageal or vascular temperature probe
- Wait until >30°C to adrenaline and give twice as frequently
- If PEA on ECG, CPR may precipitate VF once started
- Bradycardia is atropine unresponsive

BE AWARE OF

- Unreliable temperature probes in the field
- Elderly, young, alcoholic patients at risk (and beta-blocked etc)
- Coagulopathy, metabolic acidosis & hypothermia in trauma patients
- Cold diuresis & severe dehydration
- BP collapse on re-warming

COLD WATER IMMERSION

WEM Conference Speaker Gordon Giesbrecht coined the 1-10-1 rule which describes the three phases of cold water immersion. Whilst widely used, please note this is conceptual only and has been criticized by some for a lack of scientific rigor. [12]

A casualty has :

1 MINUTE	to control their breathing – gasp response followed by hyperventilation causes aspiration and drowning.
10 MINUTES	to self rescue – either swim to shore or climb on top of the ice before the casualty loses effective use of their arms, legs and fingers and becomes incapacitated.
1 HOUR	before falling unconscious from hypothermia.

A flotation device (life jacket, PFD) improves survival at every stage and is a key component of water safety and prevention.

Professor Mike Tipton describes 4 stages of cold water immersion as follows:

1.INITIAL RESPONSE

First 3-5 minutes. Skin cooling leads to the ‘cold shock response’. gasping with risk of salt water aspiration. (Lethal dose of salt water is 1.5 litres and the initial gasp is typically 2-3 litres in studies.)

2.SHORT TERM RESPONSE

Next 5-30 minutes. Superficial nerve and muscle cooling.

3.LONG TERM RESPONSE

Next 30 minutes plus. Cooling of deep tissues.

4.POST-IMMERSION (DURING RESCUE)

Collapse of arterial pressure (hence need to keep casualty in horizontal position) and risk of continued cooling.

The initial and short term responses are thought to account for 56% of deaths.[14]

FREEZING COLD INJURIES TREATMENT

FROST NIP MANAGEMENT

10 min re-warm in an armpit, groin or palm of hand, don’t rub. Don’t need to evacuate if a first episode. Clothing & Weather check. If sensation does not return in 30 mins, treat as frostbite. Prognosis: Resolves completely.

FROSTBITE MANAGEMENT

- Protect from cold and start hypothermia treatment first, hydrate
- Evacuate (can walk on frozen foot to evacuate if desperate).
- Only warm once certain can avoid re-freezing. Use a water bath and warm fast (42°C). Fire is too erratic as heat source.
- Once re-warmed, cannot use limb, don’t put any pressure on the tissues (handle like porcelain and don’t rub.)
- Loosely bandage with non-stick dressing (especially between fingers).
- Avoid bursting blisters

- Give oxygen if >4000m
- Start Aspirin 75mg OD, Ibuprofen 400mg TDS (Inhibit Plt & PG toxins)
- Analgesia for pain (IV if possible – or strongest alternative)
- Give Abx if suspicion of infection
- Tetanus booster if required
- DELAY AMPUTATION
- Staging & prognostication of frostbite is difficult in the field
- Evacuate to specialist center for angiography & Iloprost (PGI2) infusion
- <24h but even 5 days delay can still be worth it!
- Hyperbaric 02 may also be useful & Thrombolysis
- Take daily photos
- Email chrisimray@aol.com BMC Frostbite Advisory Service

OTHER CONSIDERATIONS

- Eyelids frozen shut (Cover with a hand until thaws and re-open eye)
- Cornea frozen (Cover with a hand until thaws and cover for 48h - Evacuate – risk for wind or arctic marathon runner)
- Polar thigh & polar penis (Evacuate)

EXTREME ENVIRONMENTS: TROPICAL

TROPICAL MEDICINE

Jungles can give the outward appearance of tropical paradise, but dense jungle easily ranks as one of the most hostile environments to humans on earth.

In a jungle environment the ability to dissipate heat becomes severely impacted due to the combination of high ambient air temperature and relative humidity. [1] The high heat and humidity contribute to an abundance of natural resources including flora and fauna, but with that comes infectious tropical diseases and a range of biting and venous insects and animals. Visitors to the tropics can expect to spend much of the time feeling hot, wet and itchy! Feet readily become macerated, clothing rots and small wounds quickly become infected.

TROPICAL DISEASES

Tropical disease are a leading cause of global morbidity and mortality. They afflict some of the worlds poorest populations, living between the tropics of cancer and capricorn. They are also a major consideration for visitors including tourists, expeditioners and humanitarians coming from more temperate climates.

MALARIA

An acute febrile illness that is caused by a tiny blood bourn parasite (plasmodium), spread through the bite of the female anopheles mosquito (vector).

The two main parasites are:

- p.falciparum – most prevalent in Africa and most severe, symptoms normally present within 10-15 days of an infected bite.
- p.vivax – dominant in most countries outside of Africa. Potential for delayed presentation of up to 1 year after bite. [2]

CLINICAL FEATURES

- Recurring bouts of fever
- Headache
- General malaise
- D & V
- Splenomegaly
- Jaundice
- Pallor
- Thrombocytopenia

PREVENTION

Always check if malaria is endemic to area of planned travel. Useful resource is https://www.fitfortravel.nhs.uk/destinations

Bite prevention measures include [3][4]

- Insect repellent such as:
  DEET – the most effective but irritant and destroys clothing.
  Oil of Lemon Eucalyptus (OLE)
  Avon Skin So Soft – traditionally used by UK special forces
- Wear long sleeved clothing
- Sleep under a bed net
- Treat nets and clothing with permethrin
- Public health measure: reducing areas of stagnant water near human habitation (breeding ground for mosquito larvae)

CHEMOPROPHYLAXIS WITH ORAL ANTIMALARIALS

Guided by resistance patterns in area of travel.

Daily regimens

- Doxy 100mg daily - 2 days before and 1 month after
- Atovaquone/Proguanil (Malarone) 1 tab daily - 2 days before and 1 week after

Weekly regimens

- Chloroquine 310mg weekly – 1 week before and 1 month after
- Mefloquine (Larium) 250mg weekly – 2.5 wk before and 1 month after

In pregnancy

- Advise Malarone with folic acid unless resistant area
- Mefloquine only in 2nd/3rd trimester

PREVENTION

- Seek specialist advice
- Temp control, paracetamol, IV fluids, monitor renal function
- First line - Artemisinin derivatives (e.g. artesunate) and artemisinin combination therapy (ACT)
- Quinolone derivatives - quinine, chloroquine (not in falciparum)
- Doxycycline - reduces parasite load and so can be used to augment other drugs

DENGUE FEVER

Another common tropical febrile illness caused by the dengue virus (a flavivirus) which is transmitted by the ades mosquito (vector).

The Ades mosquito has different feeding habits to the female anopheles that causes malaria being a ‘daytime biter’. The incubation period is also much shorter than malaria at only 2-7 days

CLINICAL PRESENTATION

- Abrupt onset of flu like symptoms
- Fever
- Retroorbital headache
- Body aching
- Maculopapular rash - 'febrile phase'
- Haemorrhagic tendency: bruising, petechiae, +ve tourniquet test
- Bloods low PLT and WCC and high HCT (as plasma leakage)
- Severe dengue otherwise known as Dengue Haemorrhagic Fever can progress to Dengue Shock Syndrome
- 95% of severe dengue occurs in the those aged under 15 years

PREVENTION

- Strict bite avoidance measures (see malaria above)
- The first dengue vaccine, Dengvaxia® (CYD-TDV) developed by Sanofi Pasteur was licensed in December 2015 [5]

PREVENTION

- Supportive treatment only
- Rest, hydration
- Paracetamol for fevers
- Avoid NSAIDS as increased risk of haemorrhage
- Early recognition of severe disease and escalation to hospital care

ILLNESSES FROM WATER [6]

Illnesses result from direct or indirect contact with water through 4 transmission routes:

- Water-borne
- Water-washed
- Water-based
- Water-related/Insect vector

WATER-BORNE

Consuming water contaminated with pathogenic micro-organisms such as bacteria, protozoa, parasites and viruses causing travellers diarrhoea. Whilst in most cases this is mild it can lead to severe dysentery, particularly in vulnerable groups. It is essential drinking water is taken from safe sources or is purified correctly. Please see Chapter 15 on Water and Sanitation.

WATER-WASHED

Are associated with water scarcity resulting in contaminated washing water and poor hygiene practices. This can result in the transmission of soil-based helminths, acute respiratory infections, skin and eye disease plus fleas/ticks/lice (highlights the importance of robust hygiene practices in humanitarian settings).

WATER-BASED

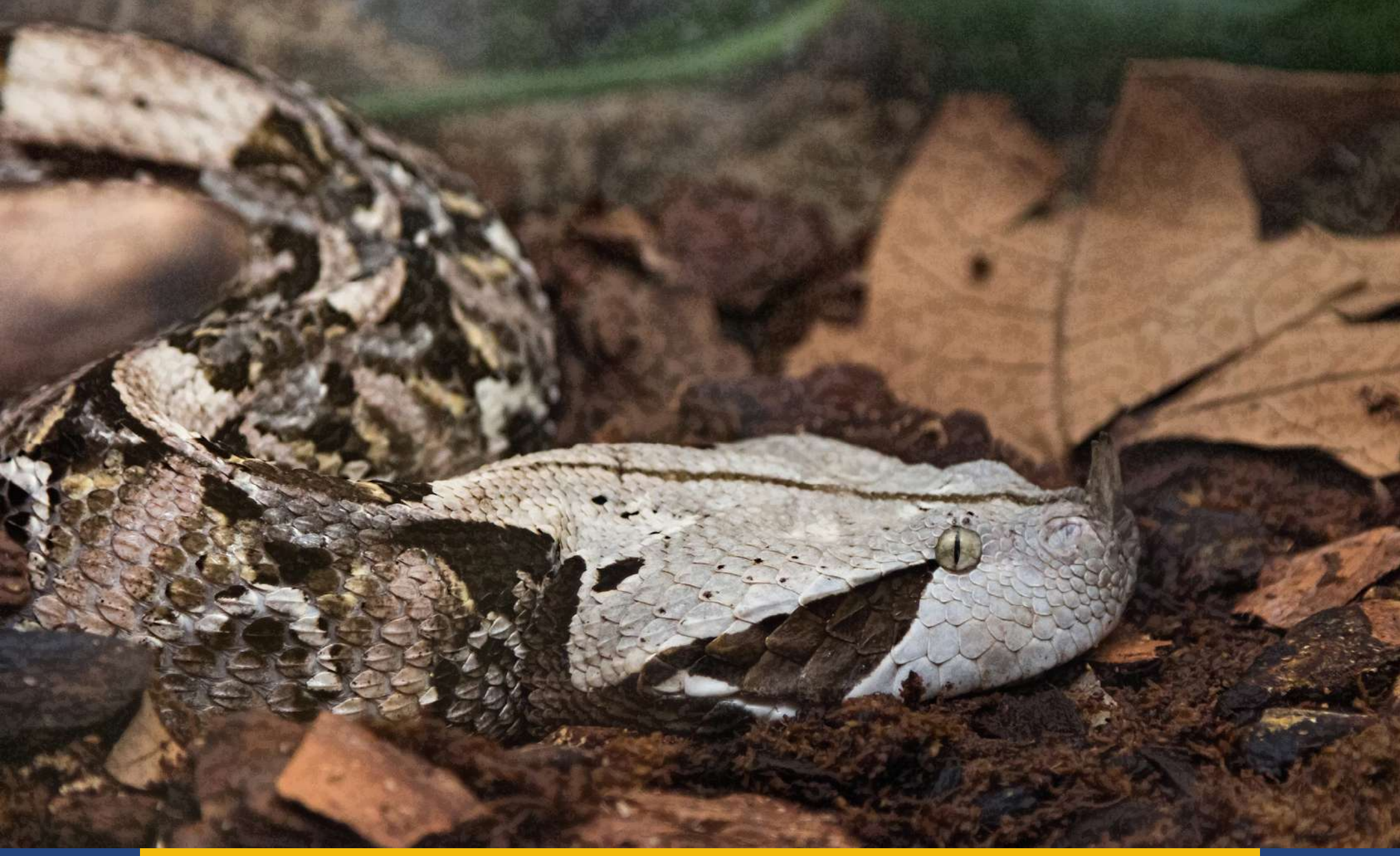
Parasites found within aquatic host organisms causing infection through skin penetration (schistosomiasis) or ingestion (i.e. fish, crayfish and crab).

WATER-RELATED/INSECT VECTOR

Insects breed in and around water sources. Mosquito borne diseases include Dengue Fever, Filariasis, Malaria, and Yellow Fever while Onchocerciasis and Ioiasis are fly-borne diseases.

ILLNESSES FROM FOOD [4]

Bacteria (66%), Viruses (4%), chemicals (26%) and parasites (4%) are the main pathogens, most commonly presenting as diarrhoea, vomiting, abdominal cramping, headache and nausea. The WHO, in addition to the Food and Agriculture Organization of the United States, identify Norovirus, Hepatitis A and, increasingly, Hepatitis E as priority pathogens. Undercooked fish, crab and molluscs in addition to raw vegetables and aquatic plants such as watercress should not be consumed. Soil left on unwashed food or hands can result in transmission of numerous parasites.



ANIMALS AND VECTORS [4]

There are 3 considerations under this category:

- Zoonotic disease through consumption of infected animals
- Zoonotic disease through direct or in-direct contact with infected vectors
- Envenomation and puncture wounds

1.ANIMAL CONSUMPTION

There is strong evidence that the consumption of wild meat significantly increases Zoonoses risk including CJD, Monkeypox, SARS, Ebola, and HIV. In 2021 60 Zoonotic viral pathogens were reportedly hosted by 105 migratory species that were studied. Medicinal use of wild meat, common-place in some cultures, pose an equal threat dependent on use. Risk of disease emergence through animal consumption is greatest in bats, followed by primates, then ungulates (hooved animals typically excluding domestic species as they are less likely to be consumed). [7]

2.DIRECT OR INDIRECT VECTOR CONTACT

Handling vectors infected with disease capable of spill-over to humans is categorised as direct transmission (e.g picking up a dead bird with Avian flu). Indirect transmission is when spill-over occurs through a means other than the vector itself (e.g eating unwashed fruit contaminated with infected animal saliva or contact with a domesticated animal that has been infected through direct or indirect contact with the vector).[8]

3.VENOMOUS FAUNA

Scorpions and spiders

- Scorpions are primarily nocturnal
- Use a head torch if toileting outdoors at night and wear appropriate footwear
- Be careful picking up firewood
- ·Shake clothes out before putting them on
- Shoes should be elevated from the ground upside down on a stick
- Shoes should be put into the sleeping bag with you if not elevated

Snakes

- Stay on trails if possible away from weeds and tall foliage
- If moving through weeds/tall foliage use a stick to poke ground ahead and make plenty of noise to warn snakes you are approaching
- Wear sturdy footwear that leaves as little exposed skin as possible
- Avoid putting your hand into dark, natural crevices
- Snakes can climb trees – be aware what is above you
- Don’t touch very recently dead snakes (biting reflex)
- Avoid camping near rocky areas or long weeds/foliage (natural habitats for snakes)
- Take note of snake colour and markings in case of bite for identification and use of correct antivenom
- If faced with a snake back off slowly to show no threat

MANAGEMENT OF ENVENOMATION [9]

- ABC's
- Keep the casualty calm and still (panic increases cardiac output and circulates more venom around the body)
- Try to identify snake species from markings (description, dead snake).
- Monitor for the development of symptoms
- Monitor vital signs
- Consider a pressure-immobilisation bandage which reduces proximal spread of the venom. Please note the application technique uses graded compression and must be done correctly for it to be effective. It is very different to applying bandaging for strains/sprains.
- Plan medevac to the nearest facility (ideally keeping patient non ambulant)

AVOID

- Cleaning, trying or applying the bite site

POISONOUS PLANTS [10]

Poisonous plants are classified according to the chemical nature of their toxic components. The following classification identifies their toxic effects;

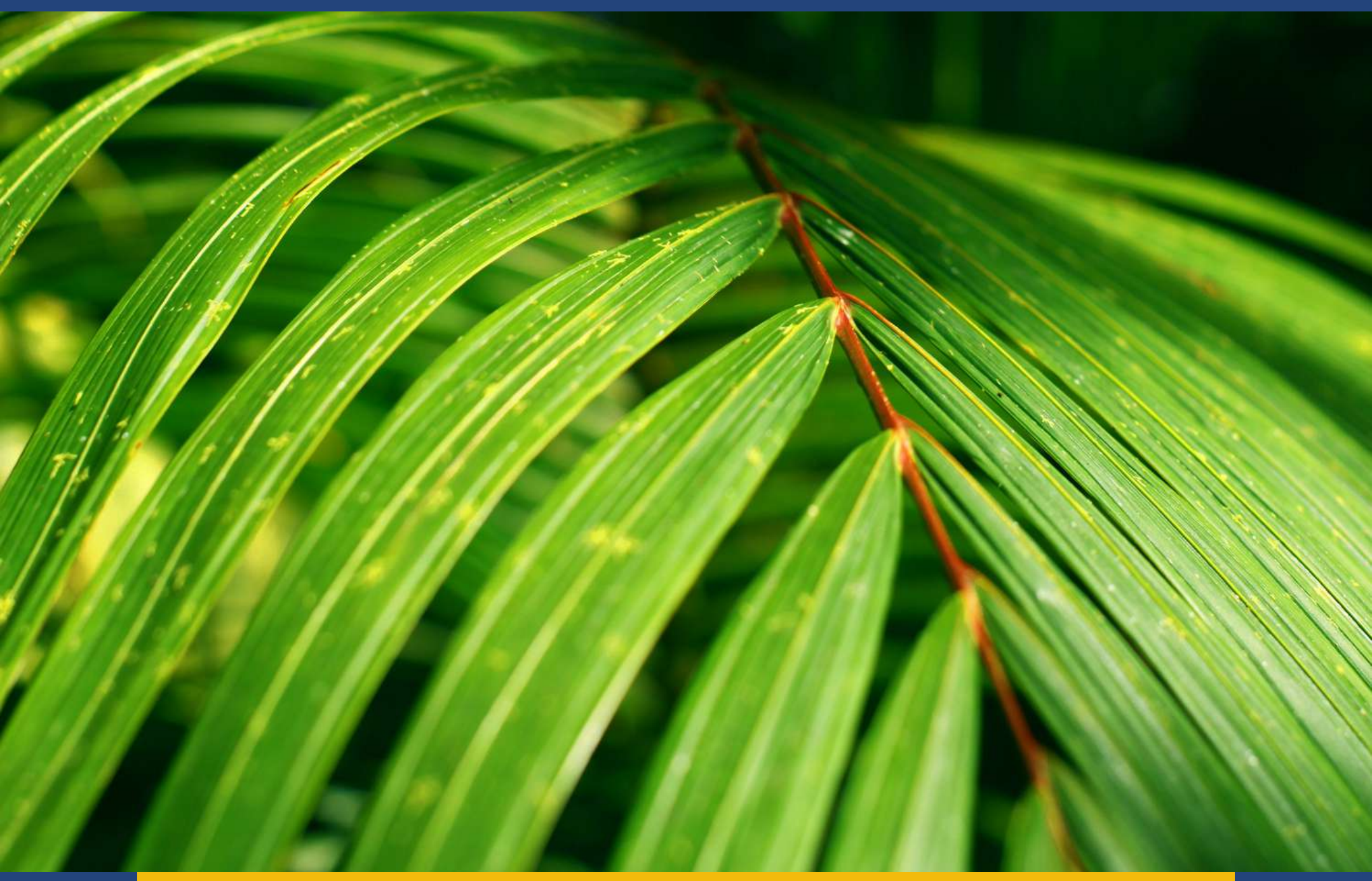
- Poisonous to consume
- Poisonous upon contact
- Producing photosensitisation
- Airborne allergies

Stems, leaves, and sap may be the cause of skin rashes while nectar or ingestion of parts may cause severe gastrointestinal upset, heart problems, nervous system irregularities, or death. Even familiar flora and fauna can catch out the undiscerning forager.

Ingestion of daffodils is a good example. Daffodil bulbs are sometimes mistaken for onions.The difference is that all parts of a daffodil plant are toxic resulting in severe nausea, vomiting and abdominal cramps. This emphasises the need for good training and a sound working knowledge before ingesting local plants.

EXAMPLE CASE

A 26 year old health blogger from China ingested Aloe Vera on live-stream to demonstrate its medicinal properties. Unfortunately, she mis-identified the plant. She actually ingested an Agave plant which contained highly irritating calcium oxylate raphides in addition to sap irritants. The blogger was taken to hospital with a numb and blistered mouth/tongue/throat. Foraging and identification of fauna is a very specialist skill and caution should be applied before ingesting anything.



EXTREME ENVIRONMENTS: ALTITUDE

ALTITUDE MEDICINE

Atmospheric pressure falls linearly with vertical ascent from sea level. Whilst the proportion of oxygen in the air remains fixed at 21%, the partial pressure of oxygen driving gas exchange in the lungs falls. This means that at the summit of Everest the inspired oxygen pressure falls to only 30% of what it is at sea level.[1] With acclimatisation, the human body can rapidly adapt to the resulting state of tissue hypoxia. However, in some individuals this may lead to the development of acute altitude illness.[2][3]

ACUTE ALTITUDE ILLNESS

It is rare for illness related to altitude to occur below 2500 metres'. Acute Altitude illness consists of 3 recognised (and overlapping) disease entities:

1. Acute Mountain Sickness (AMS)
2. High Altitude Cerebral Oedema (HACE)
3. High-Altitude Pulmonary Oedema (HAPE)

Factors increasing risk of Acute Altitude Illness include: [4][5]

- Rapid ascent
- Strenuous physical exertion
- Low degree of acclimatisation
- Younger age
- A previous history of altitude illness
- Cigarette smoking [6]

Some individuals adapt quickly to altitude (fast acclimatisers) whilst others adapt slowly (slow acclimatisers). It is worth noting, there are no definitive indicators (e.g. fitness level, body mass index, gender) for individual acclimatisation ability. As such, no assumptions of participants coping mechanisms should be made. The only true test of acclimatization ability is actually going to altitude.

INTERESTING FACT

Polar explorers may also experience hypoxia, even if they are on a lower elevation ice sheet and not high on a mountain. This is because barometric pressure falls the further you travel from the equator.[7]

PREVENTION OF ACUTE ALTITUDE ILLNESS

SIGNS & SYMPTOMS	Educate all participants on AMS signs and symptoms so they know what to look out for. This is best done during a pre-expedition briefing
ASCENDING LIMITS	Avoid ascending more than 300-500 metres per day
SLEEP	Climb high & sleep low
ACCLIMATISATION	Allow an extra day for acclimatisation every 1000m (staged ascent)
EXERCISE LEVELS	Mild exercise for the first 48 hours is preferable over strenuous activity
CAFFEINE INTAKE	Normal caffeine intake should be continued to reduce the likelihood of withdrawal headaches which could be mistaken for AMS
ACETAZOLAMIDE	Consider Prophylactic Acetazolamide 125mg PO 12 hourly for known slow acclimatisers

A planned and structured ascent facilitates acclimatisation and reduces the possibility of altitude illness, poor sleep and impaired cognitive function. [8]

ACUTE MOUNTAIN SICKNESS (AMS)

This describes a small constellation of non-specific symptoms which present in unacclimatised individuals typically 4 – 12h after arrival at a new altitude >2500. They are usually most pronounced the first night at altitude. The symptoms are:

- Headache
- Gastrointestinal upset/nausea
- Fatigue/weakness,
- Dizziness/light-headedness

The above symptomatology forms the basis for the Lake Louise Score (LLS) [2] (see section below) which is a useful clinical tool for recognition and grading severity of AMS.

Sleep disturbance, previously thought to be a symptom of AMS is also highly prevalent in healthy individuals at altitude and is more a symptom of hypoxia per-se. It is normal for individuals to experience ‘periodic breathing’ at altitude (fast/slow breathing rates, sometimes with breath holding and gasping). As such, a revision of LLS took place in 2018 removing the sleep component.

AMS TREATMENT

- **The single most important intervention is descent from altitude (or at the very least, limiting any further ascent). In most cases this will herald resolution of symptoms.[2]**
- **Acetazolamide (diamox) 250mg PO 12 hourly**

LAKE LOUISE SCORE [2]

A comprehensive tool for diagnosing AMS is the Lake Louise Score (LLS). Rated on a severity scale of 1 – 3 the score for AMS consisted of five symptoms (headache, gastrointestinal upset, fatigue/weakness, dizziness/light-headedness, and sleep disturbance). In the context of high altitude exposure, a total score >3 in the presence of headache is deemed diagnostic of AMS. In 2018 a revision of the LLS took place, removing the sleep component.

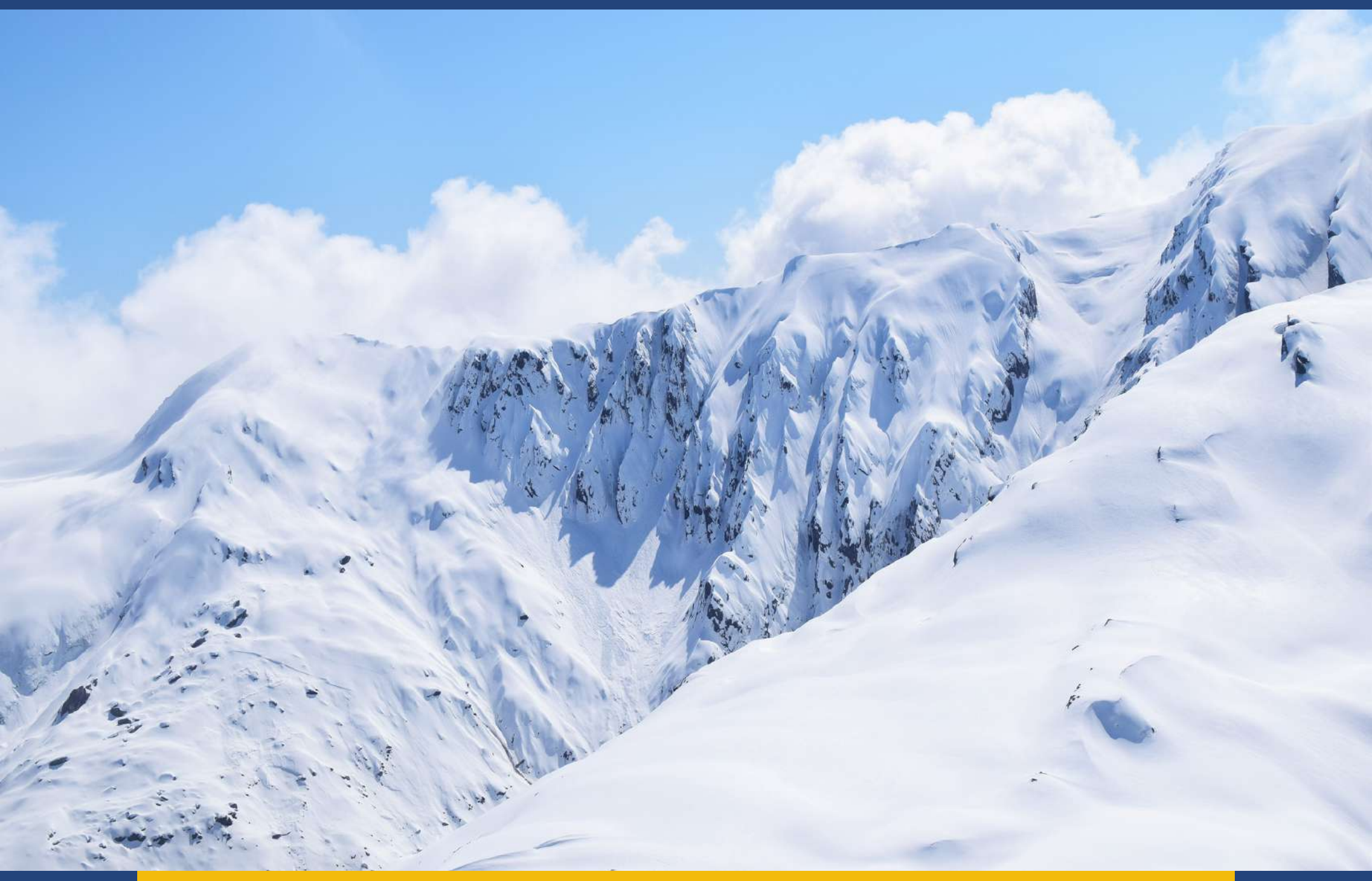
Scoring:

3-5	6-9	10-12
POINTS	POINTS	POINTS
MILD AMS	MODERATE AMS	SEVERE AMS

HIGH ALTITUDE CEREBRAL OEDEMA (HACE)

There is thought to be pathophysiological and clinical overlap between severe AMS and the onset of HACE. Both may involve a degree of brain swelling (cerebral oedema). The key differentiator is rate of onset (HACE usually presents abruptly within 1-2 hours) and the presence of neurological and behavioural features – namely incoordination, ataxia, confusion and impaired consciousness. HACE is a medical emergency and can progress to coma and death without appropriate action.

Beware: the absence of headache does not rule out a diagnosis of HACE. Signs of pulmonary oedema (HAPE, see below) may present as HACE worsens. Avoiding progression of AMS is the best way to mitigate against HACE, although this condition rarely occurs at <4000m. The estimated prevalence between 4500 – 5500m is 0.5 - 1% Immediate descent is required. [2]



DIFFERENTIAL DIAGNOSES FOR AMS AND HACE

Beware of premature diagnostic funnelling. When at altitude, it's easy to fall into the trap of misattributing all symptoms to the altitude and forgetting a full range of alternative pathologies still exist including:

- Dehydration
- Carbon monoxide poisoning
- Migraine
- Exhaustion
- Hypothermia
- Hyponatremia
- Infection
- Alcohol and drugs
- Hypoglycaemia
- Stroke and TIA
- Acute psychosis

This highlights the importance of taking a good history and making a thorough clinical assessment.

HACE TREATMENT [4]

- **A,B,C's and supportive care**
- **Immediate descent! If not feasible or safe consider the use of a portable hyperbaric chamber (discussed in the course)**
- **High flow bottled oxygen (lower if supply limited)**
- **Acetazolamide (Diamox)**
- **Dexamethasone 8mg (PO/IM/IV) as a stat dose then 4mg 6 hourly**

HIGH-ALTITUDE PULMONARY OEDEMA (HAPE)

In HAPE, fluid gathers in the lungs (pulmonary oedema) which may lead to respiratory failure. Unlike HACE, which normally evolves out of AMS, around 50% of cases of HAPE occurs in isolation, often out of the blue. Like HACE, it can develop rapidly and should be considered a medical emergency.

Early warning signs include dyspnoea, mild cough, tight chest, and reduced physical performance. In more advanced cases patients develop cyanosis, tachypnoea, increased work of breathing, chest gurgling and pink frothy sputum. [2] Aside from rapid ascent by unacclimatised individuals, also susceptible may be acclimatised individuals returning rapidly from lowlands (re-entry HAPE).

HAPE TREATMENT [4]

- **Descent**
- **Oxygen**
- **Consider portable PEEP valve**
- **Dexamethasone 8mg (PO/IM/IV) as a stat dose then 4mg 6 hourly**
- **Slow release nifedipine 20-30mg PO 8-12 hourly (avoid immediate release which can drop blood pressure).**
- **There is no role for diuretics (i.e. furosemide)**
- **Portable hyperbaric chamber.**

TRAUMA

TRAUMA- PRIMARY SURVEY (DCABCDE)

The primary survey is a rapid, systematic assessment of the patient's condition that is performed to identify and manage any life-threatening conditions. The essentials of the primary survey include:

1.DANGER

Can patient care be provided without endangering yourself or your team. Scene safety is dynamic and requires continual reassessment.

2.CATASTROPHIC HAEMORRHAGE (EXTERNAL)

Major haemorrhage is dealt with as a priority. The patient is bleeding out.

3.AIRWAY

Ensure airway is open and clear. To remove blockage or obstruction perform basic airway manoeuvres or consider advanced airway management techniques. A 'trauma jaw thrust' should generally be used in place of 'head tilt, chin lift' to protect the C spine. Be aware of potential spinal complications. Quickly check for obvious signs of trauma to the face or neck.

4.BREATHING

Assess rate, depth, and quality of respirations. Oxygen might not be available on expedition and this needs to be factored into the pre-expedition risk assessment. Quickly check for obvious signs of trauma to the chest and abdomen.

5.CIRCULATION

Assess the presence and quality of pulse/s, skin colour, temperature and blood pressure. Examine for signs of internal bleeding in the abdomen, pelvis and femurs. Be aware of the ceiling of monitoring care before you embark on expedition.

6.DISABILITY

Assess level of consciousness and neurological function and check the patient's capillary or venous glucose level.

7.EXPOSURE/ENVIRONMENT

Expose the patient's body as required to look for smaller non-life threatening injuries, however be mindful of the elements and the risk of iatrogenic hypothermia. Cut any clothing along the side seam to make covering the patient's skin afterwards easier.

SECONDARY SURVEY

Undertake a swift secondary survey looking and feeling for blood loss or signs of trauma across the whole body that may not have been apparent initially. Palpation and physical visualisation are two of the most sensitive markers in the expedition environment with acknowledgement that injuries may be early within the sequelae of their presentation.

REASSESS

Go back through DCABCDE

Fundamentally, it is the primary survey that prevents morbidity and mortality in the expedition environment. A systematic approach using DCABCDE should be used every time. If a group of clinicians is assembled the primary survey does not necessarily need to proceed in a linear, sequential fashion but as simultaneous actions. One person should lead, removing themselves from activity and overseeing process. Alongside assessment, monitoring should also occur so any life threats can be addressed immediately:

- Monitoring
- Catatrophic haemorrhage: Awareness of tourniquet application time
- Airway: Oxygen should be applied to achieve saturation of 94-98%.
- Breathing: Oxygen saturation probe (SP02). ETCO2 when available (becoming the standard of care even in the expedition environment)
- Circulation: Non-invasive blood pressure cuff. ECG monitoring
- Disability: Blood glucose. Temperature. Pupils. AVPU or Glascow Coma Scale
- Environment: Adjust patient comfort with shade or cover as required

SPINAL IMMOBILISATION

Some studies [1], [2] suggest spinal immobilisation may not always be necessary and could even be harmful in certain circumstances. A selective immobilisation approach is associated with a lower risk of adverse events and reduced time spent in immobilisation. Patients who had spinal immobilisation devices removed within 2 hours of hospital arrival had better outcomes and shorter stays. Notably the incidence of pressure sores was higher in patients who were immobilised for more than 2 hours. [3] Interestingly, vacuum mattresses are associated with shorter immobilisation times and reduced risk of pressure sores compared with long spinal boards.

Recommended guidelines for spinal immobilisation [4]

- Only immobilise the spine when there is a clear indication to do so, based on the mechanism of injury, clinical presentation, or other factors
- Spinal immobilisation may compromise the airway so this should be assessed in addition to the patient's level of consciousness
- Use a rapid extrication approach when appropriate to reduce the time spent immobilised
- Limit the use of cervical collars to patients who require spinal immobilisation

- Use a vacuum mattress, scoop stretcher or longboard, depending on the patient's condition and circumstances to ensure safe management.
- Consider early removal of spinal immobilisation devices, taking into account the patient's condition, duration of immobilisation, and the risk of complications.

There are two predominant schools of thought regarding spinal immobilisation; NEXUS guidelines and the Canadian C-spine Rules.[5] Both are similar in their approach so one example is offered below.

THE CANADIAN C-SPINE RULE [5]

A clinical decision-making tool designed to help healthcare providers determine which patients with potential cervical spine injuries need immobilisation. High-risk factors include age over 65, paraesthesia in extremities, dangerous mechanism of injury (e.g. fall from a height, high-speed motor vehicle accident), or a dangerous mechanism of injury combined with any one of the following: sitting position in vehicle, ambulatory at any time, delayed onset of neck pain, or absence of midline cervical spine tenderness.

HIGH-RISK FACTORS TREATMENT

Spinal immobilisation and obtain imaging (e.g. X-ray, CT scan) to assess injury.

NO HIGH-RISK FACTORS TREATMENT

Assess for the presence of any low-risk factors, which include simple rear-end motor vehicle collision, sitting position in the Emergency Department (ED), ambulatory at any time, delayed onset of neck pain, and the presence of midline cervical spine tenderness. If low-risk apply gentle pressure to the cervical spine while the patient rotates their head 45 degrees to the left and right. Patients absent of pain or neurological symptoms do not require immobilization.

CAUTION

Not appropriate for all patients. Clinical judgement is required to ensure patients receive appropriate care based on their specific needs and circumstances.

ROAD TRAFFIC COLLISION (RTC)

RTCs are a major global public health concern, with high rates of morbidity and mortality. According to the World Health Organization (WHO) [6], RTCs result in 1.35 million deaths per year and is the leading cause of death for 5-29 years old. A further 50 million people suffer non-fatal injuries. RTCs in low- and middle-income countries have the highest rates of road traffic mortality, with rates more than double those of high-income countries. RTCs can result in a range of injuries, from minor bruises and abrasions to more severe injuries, such as traumatic brain injury, spinal cord injury, and limb amputations. Timely and appropriate care to RTC patients can significantly impact their outcome. As an expedition medic the fundamental hierarchy of management for RTC patients involves a range of key aspects, including:

- Primary Survey
- Secondary survey
- Safe transfer: Selecting appropriate medical facilities and ensuring patient is stable with adequate medical interventions and monitoring throughout
- Communication and Documentation: Effective handovers with other medical professionals and documentation which captures vital signs, interventions, and treatments
- Emotional Support: The psychological impact of RTCs can be significant[7]
- Education: Ensure your expedition group understands the importance of safe vehicle practice (e.g. wearing a seatbelt) and you facilitate safe practice (e.g. do not travel at night if avoidable)
- Stabilise the vehicle:

1. Handbrake on – may be adequate if extrication is going to be very quick
2. Chocks under wheels
3. Deflate tyres
4. Ropes to trees etc.People holding up a half-rolled car

KEY POINTS

- Take command, watch for oncoming traffic, close the road if possible
- Danger? Rapid risk assessment
- Safe? Smash window, open door and cut seatbelt with Tuff cuts (do not lean across the steering wheel if the air bag has not deployed)
- Engines off, handbrakes on, chocks under wheels, deflate tyres, rope to tree – make secure!
- Locate fire extinguisher before you need it
- Be aware of ‘entrapment’:

1. Iatrogenic medical entrapment – potentially able to self-extricate but kept in vehicle due to medical concerns over worsening injury e.g. neck pain
2. Injury related medical entrapment – unable to self-extricate but not physically entrapped once doors are opened and seatbelt is cut e.g. unconscious patients, severe pain
3. Relative entrapment – unable to self-extricate due to physical barrier or minor compression but can be removed once assisted e.g. cutting clothing, pulling leg out
4. Definite entrapment – body part absolutely entrapped within structure of vehicle – will require more advanced extrication or amputation

- Make comfortable e.g. cut shoe open if foot caught in pedal, move seat back to access more space.
- Extricate by dragging patient out if danger escalates and there is immediate threat to life.

FRACTURE MANAGEMENT

It is logical to suggest the incident rate on expeditions will vary depending on the environment, activity and experience level of the participants.

FRACTURE CONSIDERATIONS

- Good fracture management reduces patient pain, soft tissue damage and infection risk (open injuries)
- Important to determine when medevac is necessary or if support and pain management is possible in the case of minor fractures
- Mechanism Of Injury (MOI) is key to piecing together injuries and consequential treatment
- Every fracture or dislocation should be pulled back to normal anatomical alignment
- Have a pre-hospital analgesic stepwise process in your mind (see below)
- Splints act as markers showing you are concerned enough about the structure and/or the limb to immobilise
- Splint only comes off after radiological imaging
- Pre- and post-vascular and neurological examinations should be performed on limbs

COMMON EXPEDITION FRACTURES [9]

COLLES

Fracture of the distal radius in the forearm with dorsal (posterior) and radial displacement of the wrist and hand. The fracture is sometimes referred to as a ‘dinner fork’ or ‘bayonet’ deformity due to the shape of the resultant forearm.

POTTS

A term loosely applied to a variety of bi-malleolar ankle fractures. The injury is caused by a combined abduction external rotation from an eversion force. This action strains the sturdy medial (deltoid) ligament of the ankle, often tearing off the medial malleolus due to its strong attachment.

OTTAWA RULES

A screening tool for determining the need for radiographs on acute ankle injuries shown to be effective in emergency settings [10].

Any one of the below signs or symptoms require radiological imaging:

1.OTTAWA ANKLE RULES (ANY ONE OF THESE):

Bone tenderness along the distal 6 cm of the posterior edge of the tibia or tip of the medial malleolus,
Bone tenderness along the distal 6 cm of the posterior edge of the fibula or tip of the lateral malleolus,
An inability to bear weight both immediately and in the emergency department for four steps.

2.OTTAWA FOOT RULES (ANY ONE OF THESE):

Bone tenderness at the base of the fifth metatarsal (for foot injuries),
Bone tenderness at the navicular bone (for foot injuries),
An inability to bear weight both immediately and in the emergency department for 4 steps.

3.OTTAWA KNEE RULES:

Age 55 years or older with:
Tenderness at head of fibula,
Isolated tenderness of patella,
Inability to flex to 90°,
Inability to bear weight both immediately and in the emergency department for 4 steps

PAIN MANAGEMENT

There are several pain management adjuncts and drugs that are commonly used on expeditions, depending on the severity and type of pain, as well as the availability of medical resources. Here are a few examples:

PARACETAMOL (ACETAMINOPHEN)

A commonly used over-the-counter pain reliever that can be effective for mild to moderate pain, such as headaches, muscle aches, and joint pain. It is generally considered safe when used as directed, although high doses or long-term use can cause liver damage.

NONSTEROIDAL ANTI-INFLAMMATORY DRUGS (NSAIDS)

Such as ibuprofen and aspirin are also commonly used on expeditions for pain relief. They work by reducing inflammation and are effective for a range of conditions, including headaches, muscle strains, and joint pain. However, they can cause gastrointestinal irritation and are contraindicated in some individuals, such as those with ulcers or bleeding disorders.

OPIOIDS

Such as codeine, morphine, and fentanyl are potent pain relievers that may be used for severe pain, such as that associated with fractures or surgical procedures. However, they are associated with significant side effects, including sedation, respiratory depression, and constipation. They can also be addictive and require close monitoring.

TOPICAL ANALGESICS

Such as lidocaine patches or creams can be effective for localized pain, such as that associated with sunburn or insect bites. They are generally considered safe and have fewer side effects than oral medications.

STEROIDS

Such as prednisone may be used for pain associated with inflammation, such as that associated with arthritis or asthma. However, they can cause significant side effects, such as immune suppression, and are generally reserved for more serious conditions.

PENTHROX

Penthrox (methoxyflurane), an inhaled analgesic that has several advantages in the expedition environment, is becoming increasingly popular:

- Ease of use: Does not require specialised equipment or training. It comes in a self-contained inhaler device designed for self-administration by the patient
- Rapid onset of action: Pain relief typically occurs within a few minutes of administration. This makes it an effective option for acute pain, such as that associated with fractures or dislocations
- Short duration of action: Typically lasts 30-60 minutes. This can be advantageous in the expedition environment as it allows for more frequent dosing if necessary and minimises the risk of oversedation
- Minimal side effects: The most common side effects are dizziness, headache, and nausea which are usually mild and transient

- Suitable for remote areas: Easy to administer in the field without the need for IV access or specialized equipment
- Portable and lightweight: Small and compact making it easy to transport and store in a first aid kit

It is important to note that Penthrox should be used with caution in certain populations, such as pregnant women or individuals with a history of liver or kidney disease, and that appropriate dosing and monitoring are essential to ensure safe and effective use.[11]

MAJOR TRAUMA

The national institute of clinical excellence (NICE) [12] recommend intravenous morphine as a first line treatment of major trauma, although this should be tempered with caution in the expedition environment. The combination therapy of sequential drugs has a proven literature base for effective pain relief. This can comprise of IV paracetamol that has a synergistic effect on IV morphine. IV morphine is also proven to have a synergistic effect on IV ketamine. Cautious yet prudent combination therapy can be the cornerstone to effectively managing mild, moderate and severe pain. Always remember to perform a post pain relief assessment to make sure your intervention has worked and is comparative. Finally, remember that the expedition medic will have limited access to physiological monitoring and should therefore be extremely judicial in the use of IV medication. This is especially true for opiates and NDMA antagonists (Ketamine) in an expedition environment where physiological parameters might not be acutely measured, therefore the medic should be extremely familiar with the pharmacokinetic and pharmacodynamic profile of these drugs.

CONCLUSION

Trauma in an expedition setting has many seen and unseen complexities that makes the pathology wholly unlike normal established healthcare in practice. It is extensively exacerbated by factors such as geographical isolation, lack of resources or support, and the extreme nature of the environment.

It is prudent not to forget that treatment and support for trauma in an expedition setting can involve both psychological first aid alongside trauma care. Some of the most important facets of trauma care on expedition includes risk management and preparation. The hierarchy of overriding challenges due to the unique and often remote nature of the setting include:

1. Limited resources: Expeditions often take place in remote areas where medical and psychological resources may be limited making it challenging to access emergency care or treatment for trauma.
2. Isolation: Being in an isolated environment can exacerbate the impact of trauma by limiting access to support networks and extended time to definitive care.
3. Exposure to extreme conditions: Exposure to extreme weather conditions, such as extreme cold or high altitude, can cause physical and psychological stress, which may increase the risk of injury or worsen its effects.
4. Risk profile of the expedition: The very nature of expeditions involves risk-taking and exposure to potential hazards, increasing the risk of physical injury or accident, which can lead to trauma.
5. Lack of communication: Communication can be limited or unreliable in remote areas, which can make it difficult to seek help or to contact support networks in the event of trauma.

To address these challenges, it is essential to have a comprehensive plan for the injury patterns mentioned in this chapter, including adequate training, resources, and communication protocols.

WOUNDS

WOUNDS

Determining the incidence of wounds on expedition is challenging. Whilst there is likely to be clinical documentation of serious injury and illness, wounds are often considered minor and either self-treated, or not considered important enough to document. Anecdotally, minor wounds and soft-tissue injuries make up a significant proportion of the expedition medics' workload with retrospective analysis of incident reports suggesting non-athletic soft tissue injuries could account for approximately 30% of all incidents [1].

Wounds can be classified as either acute or chronic. On expedition, the majority of wounds treated are acute (eg. blisters, lacerations, abrasions) which are expected to undergo normal healing and result in wound closure. In contrast, chronic wounds (e.g. tropical ulcers) remain at the inflammatory phase causing an incomplete or un-coordinated healing process.

WOUND HEALING

Wound healing is a complex series of events but broadly consists of two phases:

HAEMOSTASIS

To control bleeding vasoconstriction, plus a platelet and biochemical response, is activated.

TISSUE REPAIR AND REGENERATION

Involves three phases -

1. Inflammation phase (0-4 days) – normal response to injury which activates vasodilatation resulting in increased blood flow, heat, redness, pain and swelling.
2. Reconstruction phase (2-24 days) – the wound is healing with the body making new blood vessels that cover the surface of the wound. This phase includes reconstruction and epithelialisation with the wound getting smaller as it heals.
3. Maturation phase (24 days-1 year) – the final phase of wound healing, when scar tissue is formed [2].

GOALS OF WOUND MANAGEMENT

Understanding what you are trying to achieve when treating wounds provides a framework for the care delivered in the wilderness environment, mindful 'gold standard' treatment options are less likely to be available. These goals include:

1.HAEMORRHAGE CONTROL

Wound may be identified and treated during primary survey if catastrophic bleeding or life-threatening implications (eg. penetrating chest injury) result; or identified and treated during secondary survey. A stepwise approach to haemorrhage control should be followed (see 'Trauma' section for further detail).

2.MINIMISE RISK OF INFECTION

May be achieved with thorough wound cleaning and removal of foreign bodies; application of dressings to prevent further microbial contamination; or the use of antibiotics and tetanus or rabies immunisation/immunoglobulin.

3.PROMOTE OPTIMAL HEALING

Consider use of wound dressing that maintain a moist wound healing environment; ensure adequate nutrition; and attempt to reduce pressure friction and shearing.

4.REDUCE DISCOMFORT AND MINIMISE DISABILITY ASSOCIATED WITH MANAGEMENT

This may include anaesthesia and/or analgesia for wound assessment and closure or dressing changes. Consider your interventions and if they are compatible with continued performance on the expedition. For example, a bulky dressing to a frostbitten toe may give the best protection but may not allow the participant to wear a boot.

5.MINIMISE LOSS OF FUNCTION

Assess underlying structures additional to the wound to minimise the risk of function loss. Remove jewellery near the affected area.

6.OPTIMISE COSMETIC OUTCOMES

Reduce the risk of scarring for cosmetic purposes and flexibility particularly mindful of joints.

7.IMPLEMENT DEFINITIVE CARE (IF POSSIBLE)

Definitive care may include wound closure techniques; surgical debridement; or access to tetanus and rabies vaccination or immunoglobulin. Definitive care will vary depending on the wound and environment, your risk assessment and patient discussion, evacuation times and capacity of the medical team and kit. [3]

RESOURCE LIMITATIONS

In the expeditionary setting there are likely limitations on the availability of medical kit including material to treat wounds. Whilst many wound dressings would be considered light they are often bulky, even a wound of moderate size will rapidly exhaust available supplies. When a medical kit is limited by size or weight, wound care items should be adaptable for treating multiple wound types.

TREATMENT (CHRONIC WOUNDS)

This topic is beyond the scope of this manual, however if working in tropical environments it is worthwhile identifying the risk of tropical ulcers and further research appropriate antimicrobial treatment and wound management strategies.

TREATMENT (ACUTE WOUNDS)

A wound assessment in the expeditionary context involves wound examination and thorough history taking to understand injury mechanism and possible risks from the environment in which it occurred.

WOUND ASSESSMENT

- Is the patient immunocompromised?
- What is the immunisation status of the patient (tetanus and rabies)?
- Does the mechanism of injury indicate a possibly complex bacterial picture (animal bite/marine or faecal contamination)?
- What is the anatomical area of the wound and is there significant functional or cosmetic concerns?
- Is the wound in an area of the body with a high bacterial count (eg. axilla or groin)?
- What are the underlying structures and do they need assessing? If in doubt – assess!

As well as history taking it is important to evaluate the wound thoroughly. This requires a bloodless field (haemostasis needed) and may require anaesthesia to ensure patient comfort. Anaesthesia (if within your clinical skillset) may involve subcutaneous or intradermal injection of a local anaesthetic agent (eg. lignocaine). This should allow you to assess the depth of the wound and assess tissue loss; measure the wound and identify any foreign bodies or contamination that may be present. With documented consent, consider taking a non-identifiable image of the wound which may allow you to monitor wound healing (mindful of data protection and storage requirements). Assess for underlying fractures, tendon involvement and ensure the distal extremities are neurovascularly intact. Remove any jewellery distal to the injury in case the limb swells [4].

WOUND CLEANING

Wounds occurring on expedition will invariably need cleaning. The two main methods to achieve this are irrigation and debridement.

1.IRRIGATION

Preferred cleaning method and can be achieved with minimal kit. The irrigation solution most readily available and with a good evidence base is potable water. Unlike sterile saline solutions, which are heavy to carry, potable water should be available in the expeditionary environment and studies have shown no increase in the rates of infection when used in wound cleaning.

Irrigation with appropriate pressures can be achieved with a wide bore needle (or cannula) and syringe, or a cleaned water bottle or camelbak. Avoid using this method on deeper or larger wounds, however, as human saliva contains a large number of flora that may contaminate and cause infection.

2.DEBRIDEMENT

Gentle debridement can be achieved with water and gauze. In larger or more complex wounds consider dressing and immediate evacuation with delayed closure at definitive care. This includes wounds that are large, deep, contaminated and where there may be large areas of devitalised tissue. .[3]

PLANNING

After completing your wound assessment you need to determine how you wish the wound to heal -

1.PRIMARY INTENTION

Wound edges are held together using wound closure methods such as sutures, staples or tissue glue; there is minimal tissue loss and wounds tend to heal with minimal scarring eg. laceration.

2.DELAYED PRIMARY INTENTION

The wound is infected or requires a more thorough cleaning or debridement prior to primary closure. Often used for traumatic or contaminated wounds.

3.SECONDARY INTENTION

The process of spontaneous wound healing which results in scar formation and is used as a method of healing for ulcers and dehisced wounds [5].

WOUND CLOSURE

Your scope of practice, ability to maintain a clean or aseptic field, distance from definitive healthcare, access to wound closure materials, assessment of risk, and the patient's wishes will all inform your decision making process. Confidence and familiarity with wound closure and wound care is a valuable skillset and one that can be of great benefit on expedition. Working in Minor Injury Units or Urgent Treatment Centres can be an excellent way to gain further exposure to wound care.

WOUND DRESSINGS

There are thousands of wound dressings available on the market and most are sold under trade names which can make working abroad challenging. Common categories of wound dressing you may find in expeditionary medical kits include Hydrocolloid, Non-adherent dressing, Island dressing, Semi-permeable films, and Antimicrobial dressing.[6]

ANTIBIOTICS

Topical antibiotic may be considered to help maintain moist healing environment in superficial wounds. Evidence does not recommend routine use of antibiotics for wounds acquired in expedition environments. Types of wounds to consider prophylactic antibiotic use include open fractures, human bites, mammalian bites to the hand, burns (consideration), and marine environments (consideration).[3]

TETANUS

Tetanus is acquired through infection of a wound with the bacterium Clostridium tetani and is a rare but extremely serious complication of wounds. Most cases occur within 14 days of infection and can be prevented by immunisation. . The disease is characterised by generalised rigidity and spasms of skeletal muscles with a case fatality ratio between 10-90% (highest in infants and elderly).

TREATMENT

The need for active immunisation, with or without passive immunity, varies with the history and assessment of the wound and the patient’s immunisation history. Familiarising yourself with Tetanus guidelines and understanding how to assess this risk will determine if further vaccination is required [7].

According to Public health England (PHE) Tetanus prone wounds include those that are:

- Puncture wounds in a contaminated environment
- Wounds containing foreign bodies-compound fractures
- Bites and scratches from animals that are agricultural or have been rooting in soil.

The patient is at risk of tetanus if either they haven't had a full 5 doses of the tetanus vaccine over their lifetime or they haven't received a booster within the last 10 years.

Depending on the level of risk the patient may require a booster jab of the tetanus vaccine as well as in some cases a dose of tetanus immunoglobulin. These drugs may need to be sourced from a nearby health facility as they require refrigerated storage.

RABIES

Rabies is an acute viral encephalomyelitis. Infection is usually via the bite or scratch of a rabid animal, most frequently a dog and almost always fatal. There is a pre-exposure regime for rabies immunisation which alters and reduces the post exposure requirements.

TREATMENT

If bitten by an animal, wash the wound out as soon as possible with copious amounts of water (several minutes) and wash further with soap. Apply a disinfectant such as 40-70% alcohol or iodine and apply a simple dressing with the wound left open. Prophylaxis for suspected rabies exposure is of medical urgency but is not a medical emergency. It does however require definitive medical care with the initiation of post-exposure prophylaxis within 24 to 48 hours [8].

EVACUATION

Evacuation depends on the type of wound and risk to the patient. Wounds that result in significant loss of function, risk of serious infection (such as burns), or require surgical interventions are likely to require evacuation.

WATER PURIFICATION

WATER PURIFICATION

Clean, safe drinking water is essential to any expedition.

Purification means two things[1]:

1. Decontamination - removing impurities such as rock flower and other impurities from glacial outflow that can be toxins or gastrointestinal irritants.
2. Sterilisation - killing or neutralising harmful microorganisms (including bacteria, viruses, protozoa and parasites)

In practice, the focus is usually on effective sterilisation.

FOUR MAIN TECHNIQUES

1.BOILING

The CDC advises a rolling boil for 1 minute is sufficient in most cases (consider 3 minutes if at an altitude of 2000m or higher).[2] There is generally no need to boil for longer, particularly if you wish to conserve fuel.

Pros - simple, effective, always a good fall back option. Kills cyclospora.

Cons - time consuming set up. Not good for turbid water with a high organic load. Doesn't kill Hepatitis A (hence pre-travel vaccination).

2. FILTRATION

Always 2 stage. Use a coarse filter (millbank bag or fine weave clothing to remove larger grit) followed by a finer (ceramic or hollow weave) filter to remove smaller impurities and microorganisms.

Pros - Very effective at sterilisation and decontamination, minimal set up.

Cons - Most filters don't remove all viruses (requires very fine pore size). The relatively slow flow rates for finer filters means you'll need a pump system for larger volumes of water - more weight and more to go wrong. ('Gravity-fed' filters are a good option here for patient people.) Filters block and need backflushing. Ceramic filters crack at low temperatures.

3. CHEMICAL TREATMENT

Usually with chlorine based products (including chlorine, hypochlorite, sodium chlorite, and Sodium Dichloroisocyanurate (NaDCC). Essentially, it's diluted bleach which kills the small stuff but isn't concentrated enough to kill you! This typically comes in the form of a dissolvable tablet you can drop into a water container. Iodine is no longer used in the UK/EU due to EU biocide regulations introduced in 2009. [3] Iodine and chlorine are often referred to as 'halogens' due to their location in group 17 on the far right of the periodic table.

Pros - simple, very light weight. Can easily treat large volumes (good for treating group water supply).

Cons - less effective for grossly contaminated water, very alkaline or very cold water. Takes time to work (minimum 30 minutes). Cold hands, fiddly packets and gloves mean lots of fumbling, dropping tablets in the mud/snow and general cursing.

Top tip #1 - chemical treatments lose their potency once opened, so keep sealed until the point of use!

Top tip #2 - neutraliser tablets (such as sodium thiosulphate) not only neutralise the taste but also the disinfection effect if added to the water at the same time! Only add later just before drinking (or learn to love the rich tasting palate of swimming pool water!)

4. UV TREATMENT

There are two options

1. Commercial steripen - twizzle the stick for 90 seconds.
2. The 'natural' method - leave water out in a clear container for 6 hours in full sun or 3 days if overcast.

Pros - quick (Steripen), looks cool, everyone goes 'oooooooh!'

Cons - Steripens are fragile and prone to running out of batteries. Expensive. Only works for visibly clear water.

CLEAR, HIGH, FAST

As a general rule, try to find the cleanest water you can - clear, higher up, fast moving water is always preferable to cloudy, stagnant, low down sources. There is no 'perfect' method.

In many cases it's prudent to combine two methods together (especially if grossly contaminated water).

EXPEDITION DENTISTRY

EXPEDITION DENTISTRY

Dental emergencies are not uncommon, especially on longer expeditions, however much of the evidence is anecdotal, as there is relatively little data and research on the topic. Medical practitioners are, on the whole, unfamiliar with the diagnosis and treatment of dental issues, therefore basic knowledge of the most prevalent presentations will provide confidence to perform, often relatively simple procedures, to alleviate pain and temporise a situation until definitive treatment can be provided. Being able to make an accurate pain diagnosis is essential for the provision of the correct treatment. Management will be in the form of temporisation until the patient can reach a dentist. Most common issues will be broken teeth/lost fillings and periapical abscesses.

Risk Factors

- Age and past dental history of participants
- Length of the expedition

Expedition oral hygiene routines are evidenced to be significantly worse than home hygiene practice [1]. Ironically, expedition is when oral hygiene routines should be enhanced; Diet changes, often a result of consuming more sugary foods at more frequent intervals, significantly increase the risk of dental caries and dental pain. Furthermore, saliva, the natural oral buffer, is reduced by dehydration, a common expedition condition. Sugars in the oral cavity are no longer washed away, resulting in a more acidic environment, increasing the risk of dental caries and gum infections [2]. Other expedition demands which expose the oral cavity to stress include an increased respiratory rate and need to mouth breathe, resulting in a dry oral environment, and temperature extremes which can exacerbate existing dental sensitivity. A cold environment will further put teeth under increased risk of fracture from hard and frozen foods. Raised stress levels can lead to bruxism, tooth fracture and temporomandibular joint pain.

Activities and environment = increased risk of trauma to the teeth.

INITIAL PRE-EXPEDITION PREVENTION

Prevention prior to expedition is essential for the avoidance of dental emergencies.

3 MONTHS PRIOR TO DEPARTURE

Dental check-up, x-rays and copy of dental charting.

1 MONTH PRIOR TO DEPARTURE

Completion of all dental treatment to allow teeth to settle. Reinforce oral hygiene routine, use of high fluoride toothpaste and spit not rinse protocol.

DIAGNOSIS OF DENTAL PAIN

Dental pain presents differently depending on the cause.
Either

1. Result of the nerve in the tooth being traumatised.
2. Result of pressure from infection surrounding the tooth.

It is important to ask the right questions to attain the correct diagnosis [3].

DENTINE SENSITIVITY

- Sharp pain.
- Dentine layer of tooth is exposed due to recession of the gum.Temperature changes cause fluid movement toward the nerve of the tooth.

DENTAL CARIES/DECAY

- Prolonged sensitivity with a pain lasting a few minutes after stimulus is removed.
- Weakening of enamel and dentine by acids produced by bacteria, resulting in cavities.

CRACKED CUSP

- Sharp, localised pain on biting
- A crack through the coronal body of the tooth as a result of trauma or bruxism

LOOSE/BROKEN FILLING

- Sharp pain on biting but pain may be prolonged if there is underlying decay
- Previous restoration no longer retentive and moving within the tooth, or broken away from the tooth

IRREVERSIBLE PULPITIS

- Severe pain that is difficult to localise
- The decay is deep and has reached the nerve in the tooth

PERIAPICAL INFECTION/ABSCESS

- Severe, continuous aching pain and swelling. Specific tooth tender to percussion
- The nerve in the tooth has died and is necrotic. The resulting infection spreads out of the tooth and in to the surrounding bone

PERICORONITIS

- Continuous pain, localised to a partially erupted wisdom tooth. Often combined with a bad taste, trismus/reduced mouth opening and possible swelling
- Due to localised infection of the gum surrounding the wisdom tooth following food trapping

GUM ABSCESS

- Throbbing pain with localised inflammation and swelling
- Similar pain presentation to a tooth abscess (caused by decay)
- Due to the accumulation of bacteria beneath the gum. Unlike a periapical abscess, the nerve in the tooth is still alive

ACUTE, NECROTISING, ULCERATIVE GINGIVITIS (ANUG)

- Generalised gum pain - may be severe
- Halitosis, bleeding, swollen, ulcerated gums
- Caused by a bacterial infection

TEMPOROMANDIBULAR JOINT (TMJ) PAIN

- Pain around mandible, ear and temple. Can restrict mouth opening. Pain is worse when chewing or stressed
- Caused by overworking of the muscles (often as a result of stress), putting pressure on the joint. May be the result of trauma to the area, or wear and tear.

STAGES OF TOOTHACHE

1. Short, sharp pain to hot, cold and sweet. Pain ceases once stimulus removed: Early decay in enamel and dentine.
2. Pain develops in to an ache, lasting a few minutes after the removal of stimulus: Decay is progressing into the body of the tooth.
3. Tooth may become particularly sensitive to heat and develops into a continual, severe toothache: Decay has reached the nerve of the tooth.
4. Toothache appears to ‘disappear’ and all symptoms subside.The nerve in the tooth has died and is starting to become necrotic.
5. Continuous, dull, throbbing toothache. Tooth tender to percussion.The nerve is now necrotic. Infection is spreading beyond the tooth structure and an abscess is beginning to form

MANAGEMENT OF DENTAL PAIN

DENTINE SENSITIVITY	Topical application of an anti-sensitivity toothpaste or a fluoride varnish if available
DENTAL CARIES/DECAY	Remove the visible decay. Place a temporary filling to fill the cavity. +/- NSAIDs
LOOSE/BROKEN FILLING	Remove loose or broken portion of filling. Place temporary filling
CRACKED CUSP	Place temporary filling over the top of the whole tooth so that it is 'high' in the bite. NSAIDs. Be prepared for this tooth to develop in to an abscess if the crack has extended to the pulp/nerve, allowing ingress of bacteria
IRREVERSIBLE PULPITIS	Remove any obvious decay. Place a sedative dressing in to the tooth (ledermix/odontopaste/clove oil/eugenol). Abx and NSAIDs
PERIAPICAL ABSCESS	If there is a pointed swelling: incise or drain with a wide bore needle. Salt water rinses. Abx and NSAIDs. Tooth will need extraction if this does not resolve. DO NOT APPLY HEAT to the area. Cold only. If large cavity in tooth, DO NOT seal with a filling but leave open to drain
PERICORONITIS	Clean under and around the swollen gum. Irrigate with chlorhexidine or salt water, ideally in a syringe directed just under the flap of gum covering the wisdom tooth. Regular mouthwashes. NSAIDs and Abx if not resolving with local measures
GUM ABSCESS	Irrigation beneath the gum margin with chlorhexidine. Curetting of gum pocket if possible, to establish drainage. Abx. NSAIDs
ACUTE NECROTISING ULCERATIVE GINGIVITIS	Chlorhexidine mouthwash. Abx (metronidazole first choice)
TEMPOROMANDIBULAR JOINT	NSAIDs. Restrict mouth opening. Cutting food into small portions.

ANTIBIOTICS AND ANALGESICS [4]

Depends on what you have available. Can use Co-amoxiclav 650mg to avoid the need to carry lot of antibiotics. Otherwise, if available:

NO ALLERGY TO PENICILLIN

1. Co-amoxiclav 500/125mg 3 x daily, 5 days
2. Amoxicillin 500mg + Metronidazole 400mg 3 x daily, 5 days

ALLERGY TO PENICILLIN

1. Metronidazole 400mg 3 x daily, 5 days
2. Erythromycin 500mg 4 x daily, 5 days
3. Clindamycin 150mg to 300mg 4 x daily, 5 days
4. Clarithromycin 250mg 2 x daily, 7 days.

ANALGESIA

1. Ibuprofen 400 to 800 mg 4 x daily
2. Paracetamol up to 1000mg 4 x daily (+/- ibuprofen dose)
3. Diclofenac sodium 50mg 3 x daily

DENTAL TRAUMA

Emergency dental treatment is dictated by the type of traumatic dental injury as classified by the World Health Organisation. All require analgesia, soft diet, careful oral hygiene, chlorhexidine mouthwash (if available) and further investigation when they return home.

CONCUSSION

Minor impact. Not mobile, no blood. Pain: mild.
No treatment indicated

SUBLUXATION

Minor impact. Movement of tooth within socket
Mobility: <1mm. Pain: moderate. Bleeding gingival margin: mild
May need to splint for comfort

EXTRUSION

Moderate impact. Displacement of tooth out of socket.
Mobility: >1mm in horizontal and vertical plane. Pain: moderate.
Bleeding gingival margin: significant.
Gently rinse any exposed tooth. Reposition into socket and splint

LATERAL LUXATION

Severe impact. Displacement of tooth in any direction except axially. Non-mobile (usually). Pain: mild. Bleeding: moderate.
Gently rinse tooth to clean debris. LA to reposition tooth in socket. Splint 2 weeks.

INTRUSION

Severe impact. Apical displacement of tooth in to the alveolar bone.
Mobility: Nil. Pain: mild.
Do not attempt treatment

AVULSION

Tooth completely dislodged from socket
Bleeding: significant.

- Check for bone fractures and damage to other teeth
- Reimplantation: prognosis up to 80% if within an hour [5]
- Contraindications: unconscious casualty. Head or spine injuries or a medical emergency - these take priority [6]
- Transport tooth in patient cheek sulcus or saliva
- Always handle by the crown, NEVER touch the root
- Gently rinse root with saline (or boiled and cooled water)
- Remove clot and stimulate bleeding
- Position tooth in socket to full depth and patient to bite on to wooden spatula or folded card until haemostasis achieved (4-8mins)
- Create splint (options: paperclip, folded foil, face mask, nose strip)
- Dry teeth and attach splint across tooth and adjacent teeth with glass ionomer cement
- If no dental materials, use Liquiband or Dermabond Antibiotic 7 days
- Dental review asap [7]

TOOTH FRACTURE

Initially assess for luxation injuries
Minor (enamel only): file any sharp edges. Topical application of anti-sensitive toothpaste
Moderate: Up to half the tooth (no bleeding from the pulp within the tooth): Glass ionomer temporary filling
Severe: Pulp within tooth is exposed: Cement fractured fragment back on if possible. If not, ledermix lining over pulp and temporary filling.

DENTAL LOCAL ANAESTHETIC

3 methods: Regional nerve blocks, Infiltrations or Intraligamentary.

- Buccal, palatal, lingual infiltrations for all teeth except lower molars which need inferior alveolar nerve block.
- Pain relief up to 3hrs.
- Check dental syringe-needs specific needles (gauge 27 or 30 with at least 3cm length) [4].
- Lignospan 2% lidocaine with 1:80,000 adrenaline.
- Alternative (less comfortable), use standard syringe with 25g needle for infiltrations and 23g for IDB [7]

WHEN TO DENTEVAC (4)

Possible risk of airway obstruction from trauma or swelling. Suspected Ludwig's angina, Post-septal extension of maxillary abscess, facial fractures, sepsis, uncontrolled bleeding.

MENTAL HEALTH

MENTAL HEALTH

In the context of operating in challenging outdoor environments mental health can be viewed from two opposing perspectives. On the one hand wild, outdoor environments have been found to boost mental health & wellbeing in supported, low-stress scenarios.[1]

On the other hand the demands of expedition life, coupled with pre-existing mental health issues, may be difficult for some people to navigate and lead to significant psychological difficulties. Individual response to a given scenario differs widely.[2]

Medical professionals themselves are faced with their own personal challenges when operating in remote outdoor environments and therefore must be aware of their own needs and vulnerabilities and practice excellent self-care.

INCIDENCE & IMPACT ON EXPEDITIONS

There remains a dearth of literature around mental health incidents on expeditions. The most comprehensive study to date was done during the period of 2004 – 2008 in which expedition doctors recorded illness and injury during 232 expeditions.[3] During this study period there were 16 reported psychiatric incidents, of which 13 were exacerbations of previously diagnosed depressive illness, 1 was a case of acute psychosis, and 2 were cases of 'hysteria' (for the record, hysteria is not a recognised psychiatric diagnosis!).

This data makes a strong case for the need to identify participants who suffer from pre-existing depressive illness (or indeed any long-term mental disorder) in advance of deployment via pre-expedition medical questionnaires. This can be challenging as non-disclosure is common, with one study recording rates of declared pre departure mental health history of between 0.95 and 1.5%.[4] Given that around 25% of people in the UK experience some form of mental health problem in a given year [5] this is likely to be a gross underestimate of the true disease burden. Non-disclosure is likely driven by both high levels of stigma around mental illness and concern by participants that they may be excluded from the expedition.

Raleigh International is an organisation that takes large numbers of young people ('venturers') overseas to work on community, environmental and trekking projects. A detailed unpublished review of their medical incident data in 2018 examined a total of 2119 medical incidents across their global operations. Whilst only 3.5% of medical incidents overall related to mental health problems, it represented 66% of cases deemed serious enough for the venturer to be removed from the programme and returned home. Therefore, the impact of mental health conditions in these environments must not be underestimated. [6]

PSYCHOLOGICAL MORBIDITY VS PSYCHIATRIC DISORDER

PSYCHOLOGICAL MORBIDITY	PSYCHIATRIC DISORDER
Emotional and behaviour response to situation • Emotions might include anger, guilt, sadness, stress, frustration. • May be considered as being part of normal human experience	Clinical, pathological, diagnosis (i.e. generalised anxiety, depressive disorder, acute psychosis) • Significantly impacts on normal functioning • Much more likely to causes serious problems on expedition

Applying the biopsychosocial template can help us to formulate the reasons why certain individuals are at risk of mental health problems, why these present in the wilderness setting, what factors cause them to persist (rather than get better) and what the protective factors might be. This is a broader understanding of the context to what is happening rather than applying a neat and often overly reductionist ‘diagnostic label’. In the world of psychiatry these are termed predisposing, precipitating, perpetuating and protective factors.[7]

BIOPSYCHOSOCIAL TEMPLATE

Predisposing Factors • Undisclosed mental health problem • Stress in home or work life (sometimes the reason this person has gone on expedition in the first place – what are they running away from?) • Social and economic factors	**Precipitating Factors** • Stressful or traumatic event (i.e. major altercation with another participant) • Non-adherence to essential meds • Expedition environment (sleep deprived, cold, wet, dirty…) • Loss of normal support structure • Drug and alcohol use
Perpetuating Factors • The reasons people don't get better quickly • Loss of usual support networks • Lack of access to medication and specialist care	**Protective Factors** • Preserved insight • Engaged and cooperative • Premorbid personality – resilient, adaptable. • Good previous response to treatment

RECOGNISING SPECIFIC PSYCHIATRIC DISORDERS

The following criteria are based on the latest International Classification in ICD-11 [8] which replaced ICD-10 in 2020.

DEPRESSION [9]

The concurrent presence of 5 or more out of the following symptoms which must occur:

- Most of the day
- Nearly every day
- For at least 2 weeks

1. ‘Depressed mood’ (feeling low)
2. Marked loss of interest or pleasure in almost all activities (anhedonia)
3. Significant (unintentional) weight loss or change in appetite
4. Insomnia or hypersomnia (sleeping too little or too much)
5. Psychomotor agitation or retardation (physically underactive or overactive)
6. Fatigue or loss of energy
7. Feelings of worthlessness or excessive or inappropriate guilt
8. Reduced ability to think or concentrate or indecisiveness
9. Recurrent thoughts of death or suicide (suicidal ideation)

Screening questionnaires were previously widely used in the diagnosis and monitoring of depression including Patient Health Questionnaire-9 and Beck Depression Inventory. Whilst these can be a helpful 'guide' they are no longer routinely recommended for diagnosis or monitoring in the 2022 NICE Depression guidelines [10]

GENERALISED ANXIETY DISORDER (GAD)

Marked symptoms of anxiety manifested by 'general apprehensiveness' or 'excessive worry' about negative events occurring in several aspects of everyday life.

Associated features may include:

- Restlessness
- Palpitations
- Sweating
- Trembling
- Difficulty concentrating
- Sleep disturbance

Symptoms should be present for at least 'several months'

ACUTE PSYCHOSIS

Presentation is highly variable, but features may include positive and/or negative symptoms. Positive symptoms (more common features of an acute presentation):

- Hallucinations (perceptions in the absence of stimulus) – seeing or hearing things that objectively aren't there.
- Delusions (fixed or falsely held beliefs) – may include a pervasive feeling that the individual is being controlled or that thoughts are inserted into their head, being withdrawn from them or are broadcast for others to hear
- Disordered speech and/or behaviour – a general lack of coherence, based around what they are normally like.

Negative symptoms (more likely in chronic psychotic illness):

- Blunted emotion
- Reduced speech
- Reduced motivation
- Self neglect and social withdrawal

ACUTE DELIRIUM

Sudden behavioural change that develops over hours to days. Symptoms fluctuate and can include:

- Disorientation
- Slow responses
- Confusion
- Drowsiness
- Difficulty concentrating
- Rambling or disorganised thinking

Hyperactive delirium – agitation, restlessness, wandering behaviour.

Hypoactive delirium (more common) – lethargic, quiet, withdrawn.

Delirium is frequently triggered by a physical cause, which could be anything from electrolyte imbalance to altitude illness to head injury. Therefore, patients require a full medical assessment.

RISK ASSESSMENT

Risk to self

- Suicide
- Self-harm
- Self-neglect

Risk to others

- Aggression/ violence
- Erratic behaviour endangering the group

A number of risk assessment tools have been developed, however they are ‘blunt instruments’ and no tool has been found to inform accurate prediction. [11]

The emphasis has shifted in recent years onto progressive questioning, weighing up of risk and protective factors and an individualised assessment of overall risk to make a reasoned judgement on whether that an individual is low, moderate or high risk.

To inform this assessment it's helpful to gather and corroborate information from different sources where possible (such as the patient, their tent mate, other observations by expedition staff, the patients doctor in their home country, their next of kin etc).

RISK LEVEL	PRESENTIATION	POSSIBLE ACTIONS
LOW RISK	• May have thoughts of harming self/ others but: • No expressed intent to harm self/others • No plans to carry out thoughts • A number of protective factors (i.e. "I love my wife and kids back home too much I couldn't put them through that")	• Monitor • Support • Keep calm
MODERATE RISK	• More developed and pervasive thoughts of harming self/ or others but still no true intent or plans • Less protective factors	• Consider evacuation • Close monitoring • Regular reassessment
HIGH RISK	• Expresses true intent to harm self/others • May have made plans • May have access to lethal means • Has no protective factors	• Urgent medevac to a place of safety and definitive care • Remove access to dangerous means (i.e. sharp tools, ligatures) • Consider close 'line of sight' supervision at all times

CONFIDENTIALITY

The assessment and management of mental health crises requires information gathering and sharing with the wider expedition team. Wherever possible it is important to do this with the expressed consent of the patient involved. Where this consent is not obtainable (i.e. the patient severely distressed or unable to engage) then share only the minimum information necessary to manage the situation and keep the patient safe, keeping their best interests at heart [12] . It's common for other expedition members to want to know what is going on, but do not disclose details about the case unless you have consent, or there is an operational necessity to do so.

WILDERNESS PSYCHOLOGICAL FIRST AID (WPFA)

This has become an emerging field in its own right and has evolved out of conventional Psychological First Aid (PFA). It is a popular approach, although evidence for it's effectiveness particularly in disaster and trauma settings remains lacking. [13] A range of different providers offer specific training on the initial assessment and management of mental health crises in the wilderness. Including:

- Survive First Aid
- Waypoint Wilderness Survival School
- Mental Health Wilderness First Aid

The above courses are largely pitched at non-medically trained first responders and teach broad principles rather than specific medical management.

Laura McGladrey is a psychiatric nurse practitioner who frequently writes on this topic. Her 5 components of WPFA involve creating the following 5 conditions:

1. Safety – deactivate the fight and flight response
2. Calm – be mindful of how you speak and act, calm yourself so that you can calm your patient
3. Self-efficacy and collective efficacy - actively involve the patient in making a plan of action to avoid helplessness and victimhood
4. Connection – use their name, build rapport, connect the patient in with loved ones and next of kin
5. Hope – identify specific, accurate and positive facts about the situation. Remember suicide is a very permanent solution to a temporary problem. A positive approach benefits both the individual and the wider team

PROVIDER SELF-CARE

1.Try to spend some time alone each day to regroup through quiet contemplation, reflection, reading a book, meditation, taking a walk. In case there's an emergency always tell people where you're going, don't stray too far from camp and take a radio or mobile phone with you.

2.Keep your strength up by making sure you sleep and eat well wherever you can.

3.Find a confidante. Identify another member of staff who can chat things through with you and arrange regular debriefs together. Make sure your conversation remains kind and respectful.

4 Model vulnerability. If you are having an 'off day' or are really feeling the heat or the altitude, then it's ok to let the rest of the group know. You are still, after all, only human. This approach has the added benefit of giving others permission to feel: creating an open dialogue for them to disclose difficulties they may be having rather than bottling them up.

5.Having said that - don't be a moaning Minnie! Yes, let people know how rough you're feeling, but avoid dwelling on this all day long. Chances are, everyone else is feeling it too.

MEDEVAC

MEDEVAC

Both terms medevac and casevac involve transporting an injured or sick casualty away from the initial point of care (typically in a wilderness setting) to a more definitive and secure location for more advanced treatment.

Casevac is a term most often used in the military and is usually applied to war zones in which the casualty is removed swiftly from the battlefield over shorter distances often without accompanying medical staff. Typically this is a time critical movement and may be under fire.

Medevac is the term used more often in the expedition space and normally implies longer distance transfer accompanied by medical equipment and personnel. Some medevacs are time critical, others are more planned repatriations returning patients from overseas to their home country to continue treatment.

In both cases the means of transport may include any combination of the following assets:

- Casualty carry with stretcher or other means
- Vehicle
- Boat
- Fixed wing aircraft (aka planes)
- Rotary aircraft (aka helicopters)

Providing ongoing care, facing backwards in the back of a cramped, noisy, moving vehicle is an artform in itself.

Alongside managing the patient you may also be dealing with your own motion sickness, trying not to fall over, untangling lines and discovering key bits of kit are running low on batteries!

PREPAREDNESS

Every expedition should have a robust medevac plan. It's essential medics are familiar with this and ideally involved in writing it. Key components of a robust plan include:

WHAT ASSETS ARE AVAILABLE?

It's equally important to know the limitations of each asset. For example, is the helicopter and pilot rated for night flying? What kind of sea conditions would prevent a boat transfer? Who are the key contacts to co-ordinate appropriate transport.

WHERE ARE THE NEAREST HEALTH FACILITIES?

What level of care do they offer (i.e. are there ICU beds or just HDU) and what specialties are present (i.e. where is the nearest neurosurgery unit? Where is the nearest hyperbaric chamber). It pays to physically visit these facilities to check them out and make notes.

WHICH COMPANIES COULD TRANSFER A CRITICALLY ILL PATIENT?

For less critical ambulant patients where is the nearest airport and what are the flight times to the nearest international transport hubs.

WHAT KIT WILL BE REQUIRED TO STABILISE PATIENTS DURING TRANSFER?

Ensure you have provision for the following[1]:

- Stretcher/carrying device (i.e. basket stretcher, vac mat or Stokes litter). Ensure in advance that whatever you're using physically fits within the vehicle/aircraft cabin.
- Airway equipment (including ET tubes, igels and guedel and NP airways in different sizes), suction.
- Breathing/ventilation equipment including bag/valve/masks, sufficient bottled oxygen, masks and tubing.
- Circulation equipment including IV cannulas, giving sets, fluids.
- Drugs such as adrenaline, ketamine, midazolam, propofol, glucose etc with the correct diluents and the means to draw them up
- Monitoring equipment including 3 lead ECG, sats, BP cuff as bare minimum.
- PPE including gloves, apron, sharps boxes.

(Please note the list above is a guide only and is not all inclusive).

Ensure kit is contained in secure, clearly labelled and robust bags that staff are familiar with through regular team training.

Plan for failure and build in ‘redundancy’ ensuring there are back up options for key pieces of kit. It’s essential kit is checked regularly.

CONTACTS LIST, CHAIN OF COMMAND AND COMMS PROTOCOL

It’s equally important to know the limitations of each asset. For example, is the helicopter and pilot rated for night flying? What kind of sea conditions would prevent a boat transfer? Who are the key contacts to coordinate appropriate transport.

CASUALTY CARRIES

There are a number of different techniques for carrying casualties over distance that we teach on the EWM course. Some of these use purpose made equipment whilst others involve improvised techniques with rope, sticks or even rucksacks. On Kilimanjaro porters use a modified wheelbarrow or ‘bell stretcher’ to ‘run’ casualties down the mountain, it’s not a pleasant ride! [2]

One thing is universal: people are heavy! You will need to recruit a number of people, ideally 3 on each side and on rotation to achieve any significant distance, especially over rough terrain. On high-angle terrain you may also need access to rope and anchors.[3]

Some key principles:

- Make sure the casualty is secure, dropping them is an extremely bad look
- Allocate one person to lead the lift to coordinate your efforts. This is normally whoever is at the head end, ‘When everyone is ready I’m going to say ready, steady, lift are we ready?’
- Keep the casualty warm and protected from the elements. Consider putting them in a sleeping bag with a tarp over the top

- Continually check in with and reassure a conscious casualty, the whole process can be terrifying for them
- Consider nominating a ‘litter captain’ who calls out obstacles in front to those behind who will struggle to see where their feet are
- Switching sides (using a different arm) can be as good as a rest in consecutive carries

HELICOPTERS

These are a rapid and effective way of getting casualties to safety in a range of environments, however they have a significant number of limitations to be aware of including:

- Adverse weather, high altitude and night time can affect clearance to fly
- Expensive assets to maintain and staff
- Limited range and payload (usually not an option for multiple casualties)
- Relatively risky with high accident rates compared with other transport
- Can incur significant delays at each end due to difficulties loading and preflight checks. Medical crew will also need to be briefed on procedures on ditching over water
- In-flight emergencies are very difficult to manage due to cramped conditions and will likely require landing of the aircraft at the nearest safe location
- Many health facilities do not have dedicated helipads and therefore additional land transfer may be required

Top tips: Always approach the aircraft from the front and await a thumbs up from the pilot before you start walking.

PACKAGING A CASUALTY [4]

In the heat of the moment it is common for patients to be transported on unsecured extrication devices such as scoop or webbing stretchers. It's essential that patients are definitively secured to maximise patient safety, minimise movement, pain and clot disturbance in trauma and provide a mobile base for lines and equipment.

Be wary of of using hard scoop stretchers or long boards for prolonged transfers as these can be extremely uncomfortable and lead to pressure sores.

Trauma patients should be packaged 'scoop to skin', but don't forget to keep the patient warm (bear hugger, blankets or even just bubble wrap off the roll).

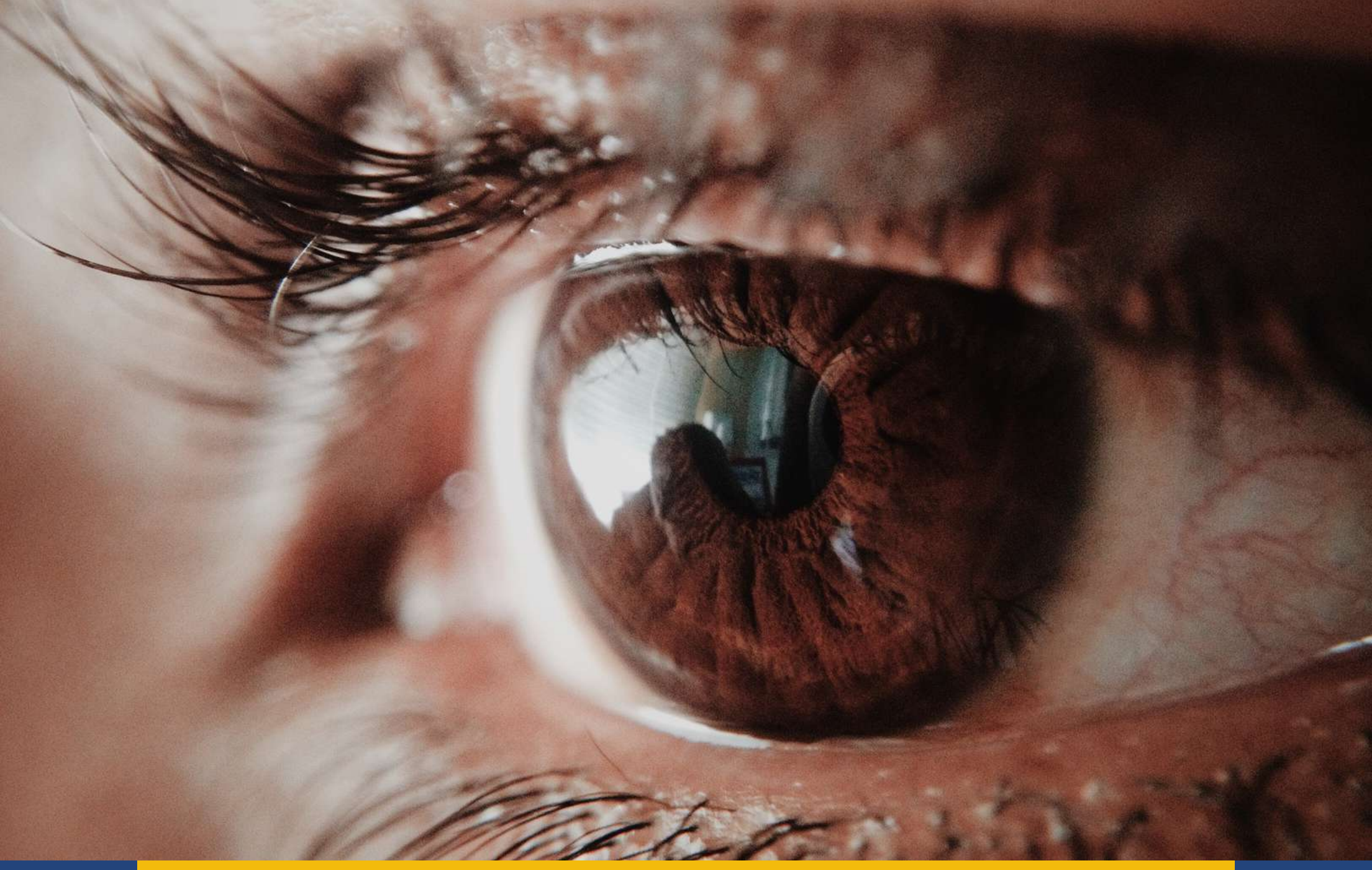
Vacuum mattresses consist of a bladder filled with Styrofoam balls. When air is removed by a pump the mattress moulds to the shape of the casualty for enhanced safety and comfort. It is not sufficiently rigid for spinal injury patients and therefore should be used alongside a rigid board.

All equipment and lines must be secured down. Often the oxygen cylinder fits nicely between the patients' legs.

Ideally, load the patient into the vehicle feet first. It is thought that deceleration forces can increase intracranial pressure. Positioning the patient near the wheelbase of a moving vehicle helps to reduce vertical forces in trauma.[5]

Pre-transfer checklists are a good method of ensuring nothing critical is left behind.

EXPEDITION OPHTHALMOLOGY



EXPEDITION OPHTHALMOLOGY

Revision of basic anatomy and physiological functions of the eye prior to reading the following chapter is recommended.

The expedition medic should be able to assess ocular function and pathology in an austere environment and be able to make informed referral and management decisions. Pre-expedition it is important to take an ophthalmic history from the participants and assess their baseline function. This would include:

- Recording of visual acuity
- Ascertaining:
  - Any refractive error? (Do they wear glasses or contacts)
  - Any amblyopia? (An eye with poor vision, when compared to fellow eye, from childhood)
  - Any previous eye surgery?
  - Any previous eye conditions?
  - Any systemic conditions?

GENERAL CONSIDERATIONS

Patients with a refractive error will use either glasses or contact lens/es (CL) for correction. When embarking on expedition it is important to take spares. In some instances, CL wearers should consider switching to spectacles. This removes the risk of CL-related keratitis; the need for inserting and removing lenses in a potentially unhygienic and uncomfortable environment; and inadvertent corneal abrasions from handling.

Users of CL are vulnerable to infective keratitis which can which can be sight threatening. There is a higher risk of this in environments where hygiene or the ability to stay dry may be an issue e.g. jungle and marine environments. CL wearers can also be more prone to suffering from dry eyes which can be exacerbated in dry, windy and bright settings e.g. polar or high altitude environments.

However, it is also important to consider the types of activities which will be undertaken; CL wear may be safer and more comfortable in certain environments. If so, strict handling hygiene as well as duration of daily wear (approximately 8hrs per day maximum) should be reiterated. Daily disposable soft CL are recommended as well as a pair of replacement spectacles. Having a prescription built into sunglasses/visors/goggles can also be considered [1].

DIABETIC PATIENTS

Should have their glycaemic control optimised, and have a dilated fundus exam conducted around 6 months prior to an expedition if possible. This allows detection of any diabetic retinopathy and potential treatment prior to departure. Most diabetics in the UK receive free annual eye screening so any problems should generally be known by the patient [1].

PATIENTS WITH GLAUCOMA

Relatively low-risk. They should continue to use any treatment they are on. If oral acetazolamide is required for the treatment of high altitude illness, this should be administered without hesitation. The only adverse effect is a transient further reduction in eye pressure which will normalise, without long-term effects, when treatment stops [1].

RECENT RETINAL SURGERY

Should be declared by expedition participants. The gases used as common tamponade agents following retinal surgery persist in the eye from 1-10 weeks post-surgery (depending on the gas used). Flying, or the use of nitrous oxide anaesthetic agents, should be avoided until the gas has completely cleared from the eye [2]. Hiking or driving to altitude should also be avoided. While the eye can tolerate and adapt to small changes in slowly occurring pressure, these activities are best avoided if there is expansile gas present [3]. There is an estimated 1.5-2 mmHg increase in eye pressure due to gas expansion for every 100m of altitude increase [4].

A general systemic enquiry should be conducted as part of all medical expedition preparation.

CORNEAL ABRASION

A corneal abrasion usually occurs as a result of superficial trauma to the front of the eye. Fingers (often the patient's own, or that of a young child), sand/grit, low-hanging tree branches/shrubbery etc are common causes. The eye is often painful. Injection or redness may, however, be relatively mild. A good history is important as sometimes patients cannot pinpoint an exact cause but understanding the environment or activities often exposes the mechanism of trauma. Vision may be reduced from excessive watering of the eye or simply from an inability to open the eye fully due to photosensitivity (the visual decline in these scenarios would be relatively mild). Corneal abrasions over the central visual axis can result in greater declines in visual acuity. It is important to check for more serious trauma (blunt globe injury or penetration, corneal laceration etc). In these cases, vision is often considerably reduced.

TREATMENT

Normally topical chloramphenicol ointment applied to the eye 3-4x/day for 3-5 days. This provides lubrication, a barrier against the elements, and antibiotic cover to the exposed area of the cornea. A topical mydriatic drop such as tropicamide 1% may be added for analgesia but this will also dilate the pupil and cause a loss of accommodation which may have undesirable effects on the patient's vision. The eye can be padded if this provides comfort, however padding has not been shown to confer any extra healing benefit. [5]

FOREIGN BODY

These are commonly embedded on the cornea but can lodge on to the conjunctival surface or become trapped under the lids. It is therefore important to conduct a thorough examination including upper lid eversion. The eye is often red, painful, and gritty and a good history can help understand the cause of injury. Sometimes there may be no foreign body present, having temporarily lodged and dislodged leaving behind a small scratch or abrasion which continues to irritate the patient.

If an obvious foreign body is seen, initial attempts at removal should be made with a clean cotton bud. If this does not work, and the practitioner is confident and competent, the edge of a 21G needle can be used to scoop off the foreign body. Viewing the eye under blue light after having instilled fluorescein dye is very useful in identifying foreign bodies. Adequate magnification and illumination should be used.

TREATMENT

After the foreign body has been removed, chloramphenicol drops or ointment should be prescribed 2-3x/day for about 3-5 days to help the irritated/damaged epithelium heal.

CHEMICAL INJURY

The cause is generally obvious and patients present with a red and painful/irritated eye. Vision is usually affected. In the field, the level of visual reduction can usually indicate the severity of the chemical injury. Alkali penetrates deeper into ocular tissues than acid and so efforts should be made to identify the causative agent in order to guide management [6].

TREATMENT

All chemical injuries should be irrigated immediately, ideally using sterile ‘normal’ saline, or in its absence, clean water.A bag of fluids and a giving set are ideal for this purpose. It is useful to instil topical anaesthetic drops prior to irrigation (e.g. proxymetacaine or oxybuprocaine). Irrigation should be carried out for a minimum of 30 mins or until the pH returns to normal (pH=7). Care should be taken not to allow the run-off from the eye to flow into the other eye. Flow onto surrounding skin should also be minimised. Hyperextending the patient’s neck and slightly turning the head towards the affected side whilst irrigating is a useful manoeuvre which allows the contaminated water to run off towards the temporal area.

Remember structure and function – if the eye looks very abnormal, or normal structures which should be visible are not (clear cornea, iris, pupil), or vision is severely affected then urgent evacuation to definitive care should be sought. Beware the completely white eye after chemical injury – this can be a sign of severe ischaemia.

Should irrigation provide some relief, with the pH returning to normal and with fairly normal vision, topical chloramphenicol ointment or drops should be given 4x/day for about 5 days with a similar dose of simple lubricating drops. If a small corneal abrasion is present following the injury, the chloramphenicol drops can be increased to 2-hourly. Large abrasions (above 35-40% corneal area) should be considered for evacuation.Topical mydriatics such as cyclopentolate 1% can used 2-3x/day for analgesia.

PRE-SEPTAL CELLULITIS

Typically results in inflamed and erythematous eyelids which can be tense and tender to touch. The infection is limited to the skin surrounding the eye while the eyeball and orbit are unaffected. Vision may be reduced due to swollen/closed lids and so the eye must be prized open to assess fully.

TREATMENT

After the foreign body has been removed, chloramphenicol drops or ointment should be prescribed 2-3x/day for about 3-5 days to help the irritated/damaged epithelium heal.

ORBITAL CELLULITIS

Occurs when the infection spreads beyond the orbital septum and into the orbit itself. It can be life-threatening.

TREATMENT

Oral antibiotics should be started in the field but immediate evacuation to definitive care (IV antibiotics +/- surgical intervention) is necessary.

Table 1: Differentiating between pre-septal and orbital cellulitis.

	PRESEPTAL	ORBITAL
PROPTOSIS	Absent	Present
OCULAR MOTILITY	Normal	Painful+restricted
VISUAL ACUITY	Normal	Reduced (if severe)
COLOUR VISION	Normal	Reduced (if severe)
RELATIVE AFFERENT PUPILLARY DEFECT	Absent	Present

EYELID LACERATION

It is important to be aware of anatomy in these cases as lacerations involving the lid margin can have a worse prognosis than those that do not (they can have long term functional and cosmetic effects). Good anatomical knowledge also allows determination of wound depth to take appropriate management steps (glue/steristrip, suture, or evacuate for specialist repair). If repairing, take care not to distort the eyelid contour and inadvertently prevent normal eyelid closure. A good history should determine the circumstances and kinetics surrounding the injury, which in turn should indicate the likely level of damage, as well as the presence of potential foreign matter within the wound (this should be removed).

TREATMENT

Attempts should be made to explore and clean the wound, and to close or repair if appropriate. At the least, it should be ensured that the eye is not exposed to the elements due to a lid defect. In serious cases, do your best to appose wound edges, apply chloramphenicol ointment, pad the eye and evacuate. Oral antibiotics (broad-spectrum including anaerobic cover if a dirty wound) should be considered to prevent cellulitis.

NOTE Severe trauma to the eyelid may also involve trauma to the globe.

GLOBAL TRAUMA

This can be blunt, penetrating or perforating:

- Blunt trauma does not involve anything entering the eye but can lead to globe rupture from the transmitted forces.
- Penetrating trauma describes an object entering the eye.
- Perforating trauma describes an object entering and exiting the eye.

Aside from in mild blunt injury, the vision is most often significantly reduced and the history often suggests a high velocity impact. The eye is painful and will look obviously abnormal. There is not much that can be done in the field with an open globe injury.

TREATMENT

Apply chloramphenicol ointment to the eye (if accessible), then a rigid shield over the eye, prescribe oral antibiotics (e.g. ciprofloxacin 500mg BD) and evacuate to definitive care. Care should be taken never to apply pressure to an open globe. Also, if ocular contents are extruding, do not try to poke them back in. And similarly, do not try to pull foreign bodies out, no matter how tempting.

CONTACT LENS WEARERS

Any red eye or conjunctivitis-like appearance should be taken seriously with immediate removal and cessation of lenses alongside the administration of intensive broad-spectrum antibiotic drops (e.g. a fluoroquinolone such as moxifloxacin hourly).The cornea should be examined for any epithelial defects (with fluorescein drops under blue light) and infiltrates (fluffy or white'ish areas) which would be highly indicative of infective keratitis.

TREATMENT

Intensive, hourly treatment with drops should continue for 2-3 days after which, if there is no improvement, the patient should be evacuated. If ocular appearances on presentation are very abnormal and/or vision is also severely affected, do not hesitate to evacuate the patient earlier. Consider administrating topical anti-fungal drops as well (voriconazole 1% or natamycin 5% hourly) if there has been dirty trauma with organic material present or if in a hot/humid climate. Fungal keratitis can progress and blind rapidly and so if there is any suspicion of this, evacuation should be immediate [2,6]. Should the eye settle on treatment, the antibiotic drops can be reduced to 4x/day for another 3-5 days and then stopped. Lubricating drops can then be administered to provide comfort for the healing ocular surface. Ideally a switch to spectacles should be made until the participant returns home.

UV KERATITIS/PHOTOKERATITIS

This occurs after over-exposure to UVB light and is essentially a 'sunburn' to the cornea. Snow, ice, and bodies of water or sand can act as reflective surfaces and the condition usually presents with bilateral red, painful, gritty and photophobic eyes. Just like sunburn to the skin, there is usually a delay between exposure and symptoms (which therefore often occur at night). History taking is important in this case.

On examination, there may be conjunctival injection, some mild haziness of the cornea and diffuse punctate fluorescein staining of the cornea when viewed under blue light.

TREATMENT

Intensive lubricating drops (ideally preservative free preparations administered 1-2 hourly) and chloramphenicol ointment 2-3x/day (this allows further lubrication and coating of the ocular surface due to the ointment, and hence more rapid healing, as well as prevention of secondary infection of the damaged corneal epithelium). The patient should be rested and light avoided. Cool, damp dressings can be applied to the eyelids and in severe cases, the eye can be padded with some jelonet and gauze. Padding may increase comfort but does not change healing time. Oral non-steroidal anti-inflammatory drugs can be considered if the pain is severe.

UV keratitis usually improves in 1-2 days but can completely incapacitate an expedition participant. This can potentially lead to life-threatening scenarios, especially if the nature of the expedition involves extended periods of solitude. Sensible precautions should be taken to prevent its occurrence - good quality eye protection with protective side pieces and 100% UV protection lenses. Porters in high altitude areas should be given eye protection too.

HIGH ALTITUDE & REFRACTIVE SURGERY

There have been reports of acute hyperopic shift (long-sightedness) in subjects who have previously undergone radial keratotomy (RK) at altitudes as low as 2744m (9000ft). There is strong evidence that these changes occur due to corneal oedema as a result of hypoxia rather than hypobaria. Significant visual loss can result (as highlighted in the case of Dr Beck Weathers on Everest in 1996). Expedition participants who have had previous RK should be made aware of this potential late complication and be advised to bring spectacles with increasing plus lens power (+1 to +3 for example) in case they run into any problems.

Techniques such as laser in situ keratomileusis (LASIK), laser epithelial keratomileusis (LASEK) and photorefractive keratotomy (PRK) have superseded RK nowadays and are less prone to causing problematic changes in vision at altitude. Studies have shown that a small myopic shift (short-sightedness) can occur at altitudes above 16000ft but these have been fairly mild and have resolved on descent.

The effects of the above procedures can vary based on individual susceptibility and participants who have had these should wait at least 3 months prior to embarking on an expedition.[6,7,8]

HIGH-ALTITUDE RETINOPATHY (HAR)

One of the four entities involved in high altitude illness. It is defined as ‘one or more haemorrhages in either eye of a person ascending above 2500m’. It occurs as a result of the normal physiological response to the hypoxia of altitude and involves retinal vascular engorgement and tortuosity.

Risk factors for the development of HAR include attained altitude, rate of ascent, duration at altitude and individual susceptibility.HAR is generally asymptomatic and affects 30% of lowlanders ascending to 5000m. The management of this condition is descent, as is that of any visual disturbance at altitude.[6]

EXAMINATION OF THE EYE IN THE WILDERNESS SETTING

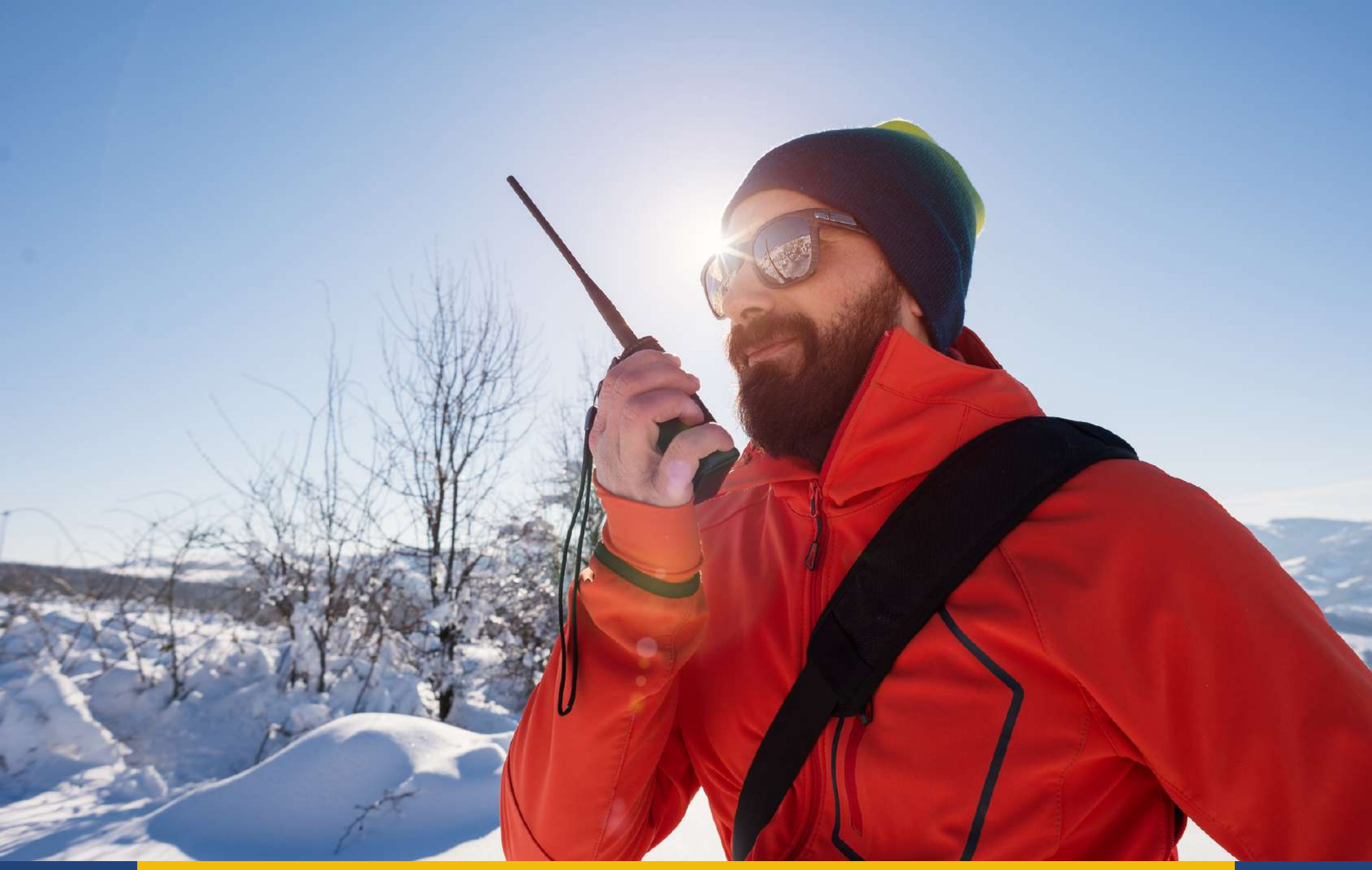
Visual acuity chart apps can be downloaded onto almost any smartphone and provide an invaluable tool that provides objective clinical data which can be shared with other professionals and guide management decisions. Failing this, any available text can be used to make a rudimentary assessment of visual acuity.

The Arclight examination device is a useful go-to tool for eye (and ear!) examination in the field:

SUMMARY

There are many conditions that can cause eye pain and visual loss in the wilderness setting. Some of these can occur anywhere and are not specific to outdoor environments whereas some are more common on expedition and the activities that are often conducted in these settings. It is important to know what is ‘normal’ for an eye in terms of anatomy and physiology. Time should be taken during learning and clinical work at home to become familiar with the structures of a normal healthy eye as well as the equipment used to examine the eye – this can be done on healthy colleagues, friends, and family. With a good knowledge of normal anatomy, it is then possible to identify abnormal signs, ask the right questions, and ultimately make the right decisions.

COMMS



COMMS

Good comms in the field is a useful secondary skill set for medical professionals, not only in terms of proficient radio etiquette but also a working knowledge of devices.

RADIOS IN GENERAL

ON/OFF - Normally controls the volume too
CHANNEL SELECT - Rotary / push button / arrow keys
PUSH-TO-TALK (PTT) - Press and hold, but wait 1-2 seconds before speaking
SQUELCH - Gradually increase squelch until background noise disappears
LOCK FUNCTION - Always use! Often the # key

BATTERY OPERATED DEVICES

Batteries have a reduced power life in the cold; be aware of battery life and carry spare (fully charged) batteries. Charge devices at every opportunity. Do regular radio checks to ensure they work, especially if you suspect you may lose signal shortly or are about to enter an important section of the expedition. No reply from your point of contact? Check the channel, the radio power, or move location for better signal. Comms equipment is fragile, once broken you may have lost your only means of evacuation.

Treat devices with tender loving care. Also, pair up the radio with a notepad and pen that works in various weather conditions; long messages should be written down.

TYPES OF RADIOS

- MF (AM) – 300KHz to 3MHz
- HF – 3 to 30MHz
- VHF (FM) – 30 to 300MHz
- UHF (GPS/4G) – 300MHz to 3GHz

COMMUNICATION ESSENTIALS

- Clarity: Speak clearly and slower than normal
- Simplicity: Avoid complicated language
- Brevity: Short and to the point
- Security: Assume other people are listening

RADIO COMMUNICATION VOICE PROTOCOL

Radio check example
‘Hello. Base 1, Base 1, Base 1. This is Radio 1, Radio 1, Radio 1. Radio check. Over’
‘Radio 1, this is Base 1. You are 5’
‘Roger. Radio 1 Out’

SIGNAL READABLE CODES

5 – perfectly readable
4 – readable with practically no difficulty
3 – readable with considerable difficulty
2 – barely readable; Occasional word distinguishable
1 – unreadable

VOICE PROCEDURE

This list is not exhaustive:

Hello	Alerts call signs of incoming message
This is	Specifies who is calling
Over	I have finished and await reply
Out	The conversation is finished. Reply not expected
Send/Go Ahead	I have received your initial call, send message
Say again	Repeat part of message e.g. ‘Say all again before…’
Negative	no
Affirmative	yes
Wait out/one	I will reply shortly
Roger	Understood
Wilco	Understood and will comply
Roger so far	Do you understand so far (long messages)
Radio check	Check communications
Figures	Transmit numbers
Grid	Pass a grid or lat/long position
Station calling	Used when unsure who is calling us
Mayday	Distress announcement, normally said 3 times
Silence/Minimise	Cease all transmissions on this network
Break	Switching from one call sign to another
Relay through	Relay messages through another callsign
I spell	I will spell out (phonetically)

PHONETIC ALPHABET

SYMBOL	CODE WORD
A	Alfa
B	Bravo
C	Charlie
D	Delta
E	Echo
F	Foxtrot
G	Golf
H	Hotel
I	India
J	Juliet
K	Kilo
L	Lima
M	Mike
N	November
O	Oscar
P	Papa
Q	Quebec
R	Romeo
S	Sierra
T	Tango
U	Uniform
V	Victor
W	Whisky
X	X-ray
Y	Yankee
Z	Zulu

HANDOVER

One acronym to facilitate short and succinct medical handover is ATMIST:

A - Age
T - Time
M - Mechanism of Injury
I - Injury
S - Signs
T - Treatment

NUMBERS

0 is pronounced as ZERO, 3 as TREE, 4 as FOW-ER, 5 as FIFE, and 9 as NIN-ER. Other numbers are pronounced as usual. Any number communications above 10 should be relayed as first number followed by second number e.g. 90 would be relayed as NIN-ER ZERO rather than ninety.

SATELLITE PHONES

Geostationary versus Low Earth Orbit (LEO)
Geostationary phones have a higher bandwidth but poor coverage in Polar regions. LEO phones have better coverage but may have shorter communications window as you transfer between moving satellites. Phones cost in the region of £500 - £1000. Other communication options you may consider include inReach (by Garmin) or SPOT, both standalone products. Alternatively, you can connect your smart phone to a satellite network such as Iridium GO.

EPIRBS AND PLBS

Emergency units registered to an individual or vessel. Once activated use 406MHz to alert the COSPAS/SARSAT system; your location will be detected by satellite (normally in less than an hour). Location is then transmitted through Local User Terminals to various Mission Control Centers worldwide, and then on to rescue assets. They can be activated by the individual or, in the case of most EPIRBs, by impact, water or water pressure.

THANK YOU FOR READING

We hope the World Extreme Medicine Expedition & Wilderness Medicine Guide proves to be a valuable resource for yourself, supporting your knowledge and confidence that you need to face the challenges of practising medicine in extreme environments.

If you're hungry for more learning opportunities, we invite you to explore our courses, membership, e-learning, and conference. We believe that ongoing education is vital to your success as an extreme and wilderness medic and we are sure that we can provide you with plenty of opportunity to do so.

Thanks again for choosing World Extreme Medicine and we wish you all the best in your future endeavours!

TRAINING COURSES | CONFERENCE | MEMBERSHIP | E-LEARNING

QUESTIONS? COMMENTS?

CONTACT US

WORLDEXTREMEMEDICINE.COM
OPERATIONS@EXTREME-MEDICINE.COM

REFERENCES

EXPEDITION PLANNING

[1] Lyon, R. and Wiggins, C. (2010) 'Expedition medicine – the risk of illness and injury' Wilderness & Environmental Medicine, Vol 4:318-24

[2] Report of REMS Titanic on History.com Originally published Nov 9 2009, Updated April 9, 2021. Link: https://www.history.com/topics/early-20th-century-us/titanic#titanic-s-lifeboats

[3]Davidson, Helen. Article in The Guardian Newspaper. An Ultramarathon ends in tragedy: runners describe the horror of Gansu race. Fri 28th May 2021. Link: https://www.theguardian.com/world/2021/may/28/an-ultramarathon-ends-in-tragedy-runners-describe-horror-of-gansu-race

[4] Root Cause Analysis. Patient Safety Network (PSNet). Sept 7 2019. Link: BSI Summary: Safer adventures: Managing the risks of adventure travel. Guide to the British Standard for adventurous activities outside the United Kingdom (BS 8848:2014) Can be accessed via the following link: https://www.bsigroup.com/localfiles/en-gb/consumer-guides/resources/bsi-consumer-brochure-adventurous-activities-uk-en.pdf. A full copy can be purchased (for £210!) here: https://knowledge.bsigroup.com/products/specification-for-the-provision-of-visits-fieldwork-expeditions-and-adventurous-activities-outside-the-united-kingdom-1/standard

[5] Kahneman, Daniel, 1934- author. Thinking, Fast and Slow. New York :Farrar, Straus and Giroux, 2011.

[6] Cherry, Kendra. Understanding the Optimism Bias. 17th Feb 2022. Theories > Cognitive Psychology. From https://www.verywellmind.com/what-is-the-optimism-bias-2795031

[7] Lyon, R. and Wiggins, C. (2010) 'Expedition medicine – the risk of illness and injury' Wilderness & Environmental Medicine, Vol 4:318-24

[8] BSI Summary: Safer adventures: Managing the risks of adventure travel. Guide to the British Standard for adventurous activities outside the United Kingdom (BS 8848:2014) Can be accessed via the following link: https://www.bsigroup.com/localfiles/en-gb/consumer-guides/resources/bsi-consumer-brochure-adventurous-activities-uk-en.pdf. A full copy can be purchased (for £210!) here: https://knowledge.bsigroup.com/products/specification-for-the-provision-of-visits-fieldwork-expeditions-and-adventurous-activities-outside-the-united-kingdom-1/standard

[9] Moonie, Jim. British Standard 8848 (BS 8848):2014. Adventure Medic Article, Core Skills, News & Features 12 July 2014. https://www.theadventuremedic.com/features/british-standard-8848-bs8848/

[10] Davis, M. (2014) 'Legal Aspects of Expedition Medicine', Adventure Medic, [Online], Available: www.theadventuremedic.com/features/legal-aspects-expedition-medicine/

[11] Mellor, A., Dodds, N., Joshi, R., Hall, J., Dhillon, S et al (2015) Faculty of Pre-hospital Care, Royal College of Surgeons Edinburgh guidance for medical provision for wilderness medicine. Extreme Physiology & medicine: 4 (22)

[12] Iserson, K. (2013) 'Medical planning for extended remote expeditions', Wilderness & Environmental Medicine, Vol 24:366-77

[13] Mellor, A (2019) Updated guidance for medical provision for wilderness medicine. Faculty of Pre-hospital Care, Royal College of Surgeons Edinburgh. Edinburgh, UK

MICROLEGAL

[1] Dobiesz VA, Sullivan W. Medicolegal Issues in Expedition and Wilderness Medicine. Emerg Med Clin North Am. 2017 May;35(2):485-494. doi: 10.1016/j.emc.2017.01.004. PMID: 28411938.

[2] French Code of Medical Ethics. Ordre National Des Medecins. November 2013. Link: https://www.conseil-national.medecin.fr/sites/default/files/external-package/edition/168yke7/code_de_deontologie_version_anglaise.pdf#:~:text=A%20doctor%20must%20not%20abandon,in%20accordance%20with%20the%20law.&text=A%20doctor%20called%20upon%20to,rules%20of%20hygiene%20and%20prevention.

[3] Daniele Bryden, FRCA LLB (Hons) MML, Ian Storey, LLB (Hons), Duty of care and medical negligence, Continuing Education in Anaesthesia Critical Care & Pain, Volume 11, Issue 4, August 2011, Pages 124–127, https://doi.org/10.1093/bjaceaccp/mkr016

[4] Boam v Friern Hospital Management Committee Case Review. https://www.healthcareethicsandlaw.co.uk/negligence-1/bolam-v-friern-hospital-management-committee-1957-bolam-test Accessed Jan 2023.

[5] Mills JA, Middleton JW, Schafer A, Fitzpatrick S, Short S, Cieza A. Proposing a re-conceptualisation of competency framework terminology for health: a scoping review. Hum Resour Health. 2020 Feb 21;18(1):15. doi: 10.1186/s12960-019-0443-8. PMID: 32085739; PMCID: PMC7035756.

[6] Mellor A, Dodds N, Joshi R, Hall J, Dhillon S, Hollis S, Davis P, Hillebrandt D, Howard E, Wilkes M, Langdana B, Lee D, Hinson N, Williams TH, Rowles J, Pynn H. Faculty of Prehospital Care, Royal College of Surgeons Edinburgh guidance for medical provision for wilderness medicine. Extrem Physiol Med. 2015 Dec 1;4:22. doi: 10.1186/s13728-015-0041-x. PMID: 26629337; PMCID: PMC4665843.

[7] Abdelrahman, W. Abdeleirahman, A. Medical Record Keeping:clarity, accuracy and timeliness are essential. BMJ 2014: 348 (2014)

[8] GMC Good Medical Practice 2013. https://www.gmc-uk.org/-/media/documents/good-medical-practice---english-20200128_pdf-51527435.pdf Accessed Jan 2023

HUMAN FACTORS, TEAM DYNAMICS AND EXTREME PSYCHOLOGY

[1] Rosen A., Salas E., Tannenbaum I., Pronovost P. and King B. (2012). Simulation-based training for teams in healthcare: Designing scenarios, measuring performance, and providing feedback. In Carayon P. (Ed.), Handbook of human factors and ergonomics in health care and patient safety (pp. 573–594). Boca Raton, FL: CRC Press

[2] Geuna, S., Brunelli, F. and Perino, M. (1996) Stressors, stress and stress consequences during long-duration manned space missions: a descriptive model. Acta Astronautica. Vol 36: 347-356).

[3] Uitdewilligen, S. and Waller, M. (2018) Information sharing and decision making in multidisciplinary crisis management teams. Journal of organisational behaviour. Vol 39 (6): 731 – 748

[4] Krakauer, J (1999) Into Thin Air: A personal account of the Mt. Everest disaster. Anchor Books. New York, US.

[5] Mangione L, Nelson D. The 1996 Mount Everest tragedy: contemplation on group process and group dynamics. Int J Group Psychother. 2003 Jul;53(3):353-73. doi: 10.1521/ijgp.53.3.353.42824. PMID: 12841099.

[6] Schultz, P. and Schultz E. (2012) A history of modern psychology. 10th edition, USA: Cengage Learning

[7] Xin, Y., Wu, J., Yao, Z. and Guan, Q. (2017) The relationship between personality and the response to acute psychological stress. Scientific Reports. Vol 7: 16906

[8] Terry, C. (1995) Efficacy of mood state profiling among elite competitors: a review and synthesis. The Sports Psychologist. Vol 9: 309 – 324

[9] Nathan, S. (2019) Relations between daily events, coping strategies and health during a British army ski expedition across Antarctica. Environment and Behaviour. Volume 53 (1).

[10] Edmonstone, J. Learning and Development in Action learning: The Energy Investment Model Industrial and Commercial Training, Vol. 35 Iss 1 ppp 26-28.

[11] Slater, M. (2019) Togetherness: How to build a winning team. Dark River. United Kingdom.

[12] Smith, N. and Wuebker, R. (2022) Basic Psychological Needs on Expedition. Exploration Revealed. Issue 2.

[13] Ryan, M. and Deci, E. (2000) Self-determination theory and the facilitation of intrinsic motivation, social development, and well-being. American Psychologist, 55

PRE-EXISITING CONDITIONS

[1] Mellor, A (2019) Updated guidance for medical provision for wilderness medicine. Faculty of Pre-hospital Care, Royal College of Surgeons Edinburgh. Edinburgh, UK

[2] Iserson, K. (2013) ‘Medical planning for extended remote expeditions’, Wilderness & Environmental Medicine, Vol 24:366-77

[3] Agarwal, M. (Year) Pre-Existing Medical Conditions. Online [Available]: www.XXXX

[4] Bhatt,S., Kim, Y. and Harrington, F et al (2018) Smoking duration alone provides stronger risk estimates of chronic obstructive pulmonary disease than pack-years. Thorax.Vol 73:414-421

[5] Rahman, A. and Paul, M (2018) Delirium Tremens. StatPearls Publishing, Treasure Island (FL) Online [Available]: https://www.ncbi.nlm.nih.gov/books/NBK482134/

[6] Kupper, T., Hettlich, M., Horz, H. and Lechner, K et al (2014) Dental problems and emergencies of trekkers. High altitude medicine & biology. Vol 15(1):39-45.

EXTREME ENVIRONMENTS: HOT

[1] Rewald, B., Eppel, A., Shelef, O., hill, A., Degu, A., Friedjung, A. and Rachmilevitch, S. (2012). Hot deserts. Life at Extremes: Environments, Organisms and Strategies. Chapter 11. CABI, Israel.

[2] Peel, M., Finlayson, B., McMahon, T. (2007) Updated world map of the Koppen-Geiger climate classification. Hydrology and Earth System Sciences. Vol 11: 1633-1644.

[3] Worlddata.Info. The Climate in Antarctica. Data Based on German Weather Services. Accessed Feb 2023. Link: https://www.worlddata.info/oceania/antarctica/climate.php

[4] Leiva, D. and Church, B. (2022) Heat illness. Stat Pearls. Treasure island, U.S

[5] Wallace, Robert & Kriebel, David & Punnett, Laura & Wegman, David & Wenger, C & Gardner, John & Gonzalez, Richard. (2005). The Effects of Continuous Hot Weather Training on Risk of Exertional Heat Illness. Medicine and science in sports and exercise. 37. 84-90. 10.1249/01.MSS.0000150018.90213.AA.

[6] O'Connor, F. and Casa, J. (2022) Exertional heat illness in adolescents and adults: Epidemiology, thermoregulation risk factors and diagnosis. Online [Available]: https://www.uptodate.com/contents/exertional-heat-illness-in-adolescents-and-adults-epidemiology-thermoregulation-risk-factors-and-diagnosis/print

[7] Heat and Health (2018) World Health Organisation. Online [Available]: https://www.who.int/news-room/fact-sheets/detail/climate-change-heat-and-health

[8] Frequently asked questions (FAQ) about extreme heat (2012) Centers for disease control and prevention. Online [Available]:
https://www.cdc.gov/disasters/extremeheat/faq.html

[9] Oxford Handbook of Expedition and Wilderness Medicine 2nd Edition. Chris Johns et al, 2018.

EXTREME ENVIRONMENTS: COLD

[1] Pocock, G. and Richards, C. (2006) Human physiology: the basis of medicine. Oxford core texts, 3rd Edition, Oxford University Press: U.K

[2] Sullivan, G. and Edmondson, C. (2008) Heat and temperature. Continuing Education in Anaesthesia Critical Care and Pain. Vol 8 (3)

[3] Change in the atmosphere with altitude (n.d). Center for science education. Online [Available]: https://scied.ucar.edu/learning-zone/atmosphere/change-atmosphere-altitude

[4] Heil, K., Thomas, R., Robertson, G., Porter, A., Milner, R. and Wood, A. (2016) Freezing and non-freezing cold injury: a systematic review. British Medical Bulletin. Vol 1117 (1):79-93

[5] The College of Podiatry (2020) Chilblains. Online [Available}: https://rcpod.org.uk/common-foot-problems/chilblains

[6] Trench foot or immersion foot (2005): Disaster recovery fact sheet. Centre for disease control. Online [Available]: www.cdc.gov/disasters/trenchfoot.html

[7] Fudge, J. (2016) Exercise in the cold: preventing and managing hypothermia and frostbite injury. Sports Health. Vol 8 (20): 133-139.

[8] Handford, C., Buxton, P., Russell, K., Imray, C., Mcintosh, S., Freer, L. Cohran, A. and Imray, C (2014). Frostbite: a practical approach to hospital management. Extreme Physiology and Medicine. Vol 3 (7)

[9] Dana AS, Rex IH, Samitz MH. The Hunting Reaction. Arch Dermatol. 1969;99(4):441–450. doi:10.1001/archderm.1969.01610220069012

[10] neurologically intact survival from a child presenting with a core body temp of 13°C after cold water immersion

[11] Cold water shock: the facts (n.d). Royal Life Saving Society. Online [Available]: https://www.rlss.org.uk/cold-water-shock-the-facts

[12] Cold water shock: the facts (n.d). Royal Life Saving Society. Online [Available]: https://www.rlss.org.uk/cold-water-shock-the-facts

[13]Rhodes, M. and Sorenson, H (2017) Polar Medicine. Auerbach's Wilderness Medicine. 7th ed. Elsevier

[14] Tipton, Mike. Cold Water Immersion: sudden death and prolonged survival. The Lancet vol 362, S12-S13, (2003)

EXTREME ENVIRONMENTS: TROPICAL

[1] Gamage, P., Finch, C. and Fortington, L. (2020) Document Analysis of exertional heat illness policies and guidelines published by sports organisations in Victoria, Australia. BMJ Open Sport & Exercise Medicine. Vol 1(6):1

[2] World Health Organisation World Malaria Report 2021 https://www.who.int/publications/i/item/9789240040496

[3] Centre for Disease Control https://www.cdc.gov/mosquitoes/mosquito-bites/prevent-mosquito-bites.html

[4] Insect bites and Stings (n.d). The Travel Doctor. Online [Available]: http://www.traveldoctor.co.uk/stings.htm

[5] World health Organisation Dengue and Severe Dengue 21 January 2022 https://www.who.int/news-room/fact-sheets/detail/dengue-and-severe-dengue#:~:text=a%20past%20infection.-,Treatment,emergency%20treatment%20and%20urgent%20referral.

[6] Rupali, P (2019) Introduction to Tropical Medicine. Elsevier public Health Emergency Collection. Vol 33 (1):1-15

[7] Coad, L., Willis, J., Maisels, F. and Funk, N etal (2021). Impacts of taking, trade and consumption of terrestrial migratory species for wild meat. Center for International Forestry Research (CIFOR). Online [Available]: https://www.cms.int/sites/default/files/publication/CMS_Report_impacts_wild_meat_terrestrial_migratory_species.pdf

[8] Han, B., Kramer, A. and Drake, J (2016) Global patterns of Zoonotic disease in mammals. Trends Parasitol. Vol 32(7): 565-577

[9] Jim Duff and Ross Anderson Pocket First Aid and Wilderness Medicine, Cicerone 12th edition 2017 pp124-126

[10] Plant Poisons (phytotoxins). Britannica. Online [Available]: https://www.britannica.com/science/poison-biochemistry/Plant-poisons-phytotoxins

EXTREME ENVIRONMENTS: ALTITUDE

[1] Peacock, A J Oxygen at High Altitude. British Medical Journal (1998) Oct 17; 317(7165): 1063–1066.

[2] Roach, R., Hackett, P., Oelz, O., Luks, A., MacInnis, M., Baillie, J. and the Lake Louise Score Consensus Committee (2018). The 2018 Lake Louise Mountain Sickness Score. High Altitude Medicine & Biology. Vol 19 (1).

[3] Luks, A., Swenson, E. and Bartsch, P. (2017) Acute high-altitude sickness. European Respiratory Review. Vol 26

[4] Kupper Th, Gieseler, U. Angelini, C. Hillebrandt, D. Milledge, J. Emergency Field Management of Acute Mountain Sickness, High Altitude Pulmonary Edema, and High Altitude Cerebral Edema Published by the UIAA. Vol 2. (2012) Link: https://theuiaa.org/documents/mountainmedicine/English_UIAA_MedCom_Rec_No_2_AMS_HAPE_HACE_2012_V3-2.pdf

[5] Wu, T., Ding, S., Lui, J., Jia, J., Chai, Z. and Dai, R (2012). Who are more at risk for acute mountain sickness: a prospective study in Qinghai-Tibet railroad construction workers on Mt. Tanggula. Chinese Medical Journal. Vol 125 (8):1393-1400.

[6] Song, P., Zhang, J., Qin, J., Gao, X., Tang, J., Tang, C. and Huang, L. (2014) Smoking is associated with the incidence of MS: a large sample cohort study. Military Medical Research. Vol 1(16)

[7] Wagner DR, Fargo JD, Parker D, Tatsugawa K, Young TA. Variables contributing to acute mountain sickness on the summit of Mt Whitney. Wilderness Environ Med. 2006;17(4):221-228

[8] Hackett, P. and Schlim, R (n.d) High-altitude travel and altitude illness. Centers for Disease Control and Prevention.Online [Available]: https://wwwnc.cdc.gov/travel/yellowbook/2020/noninfectious-health-risks/high-altitude-travel-and-altitude-illness

TRAUMA

[1] Leonard JC, Mao J, Jaffe DM. Potential adverse effects of spinal immobilization in children. Prehospital emergency care : official journal of the National Association of EMS Physicians and the National Association of State EMS Directors.

[2]Okereke I, Mmerem K, Balasubramanian D. The Management of Cervical Spine Injuries – A Literature Review. Orthopedic Research and Reviews. 2021;13:151–62.

[3]Eyal Y, Tsur N, Gendler S, Almog O, Beer Z. Spinal Backboard-Necessity or Hazard? The IDF Clinical Practice Guidelines and Policy. Military Medicine. 2022

[4]NICE Recommendations. Spinal injury: assessment and initial management.

[5]Saragiotto BT, Maher CG, Lin CWC, Verhagen AP, Goergen S, Michaleff ZA. Canadian C-spine rule and the National Emergency X-Radiography Utilization Study (NEXUS) for detecting clinically important cervical spine injury following blunt trauma. Cochrane Database of Systematic Reviews. 2018;11;4(4).

[6]World Health Organization. Road traffic injuries. World Health Organization: WHO; 2022. www.who.int/news-room/fact-sheets/detail/road-traffic-injuries

[7]Cartwright A. The Psychological Effects of Road Traffic Accidents (RTAs): An Exploration of a United Kingdom Medico-Legal Examiner's Career of RTA Assessments. Psychiatry, Psychology and Law. 2017;25(2):303–24

[8]Townes, David and Talbot, Timothy and Wedmore, Ian and Billingsly, Robert: Event medicine: Injury and illness during an expedition-length adventure race, The Journal of emergency medicine 2004;161-5 (27)

[9] Iyengar K, Vaish A, Vaishya R. Revisiting conservative orthopaedic management of fractures during COVID-19 pandemic. Journal of Clinical Orthopaedics and Trauma. 2020 May;

[10]Ottawa Ankle Rules [Internet]. Physiopedia. 2014. Available from: https://www.physio-pedia.com/Ottawa_Ankle_Rules

[11]Buntine P, Thom O, Babl F, Bailey M, Bernard S. Prehospital analgesia in adults using inhaled methoxyflurane. Emergency Medicine Australasia. 2007 Dec;19(6):509–14.

[12]Pain relief | Information for the public | Major trauma: assessment and initial management | Guidance | NICE [Internet]. www.nice.org.uk. Available from: https://www.nice.org.uk/guidance/ng39/ifp/chapter/pain-relief

WOUNDS

[1] Leemon, D. and Schimelpfenig, T. (2003). Wilderness Injury, Illness and Evacuation: National Outdoor Leadership School's Incident Profiles – 1999-2002. Wilderness & Environmental Medicine. Vol 14:174-182.

[2]Carville, K. (2017). Wound Care Manual (7th ed.). Silver Chain Foundation: Osbourne, WA.

[3] Quinn, R., Wedmore, I., Johnson, E., Islas, A., Anglim, A., Zafren, K., Bitter, C. and Mazzorana, V. (2014). Wilderness Medical Society Practice Guidelines for Basic Wound Management in the Austere Environment. Wilderness & Environmental Medicine, 25, 295-310.

[4] Purcell, D (2022). Minor Injuries: A Clinical Guide (4th ed.). Elsevier, London.

[5] The Royal Children's Hospital Melbourne (2019). Clinical Guidelines – Nursing. Wound Assessment and Management. Accessed 17th February, 2022. Online [Available]: https://www.rch.org.au/rchcpg/hospital_clinical_guideline_index/Wound_assessment_and_management/#:~:text=Wound%20management%20practices%2D%20the%20goal,to%20promote%20moist%20wound%20healing

[6] British National Formulary (BNF). Wound Management.

[7] Public Health England (2022). Immunisation Against Infectious Disease – The Green Book [ebook]. Chapter 30 Tetanus. PHE: London.

[8] Public Health England (2022). Immunisation Against Infectious Disease – The Green Book [ebook]. Chapter 27 Rabies. PHE: London.

WATER PURIFICATION

[1] Bledsoe G H et al Expedition & Wilderness Medicine. Cambridge University Press. (2009)

[2] CDC Boil Water Advisory statement https://www.cdc.gov/healthywater/emergency/drinking/drinking-water-advisories/boil-water-advisory.html

[3] https://www.outsidebusinessjournal.com/press-releases/european-union-to-ban-iodine-for-use-in-disinfecting-drinking-water/ accessed Jan 2023

EXPEDITION DENTISTRY

[1]Kuuper,T. Hettlich, M. Horz, HP. Lechner,K. Scharfenberg, C. Conrads, G. Yekta, SS. Lampert, F. Gore, C. High Altitude Medical Biology. (2014) Dental problems and emergencies of trekkers- epidemiology and prevention. High Altitude Medical Biology. Vol 1: 39-45. [Available] https://pubmed.ncbi.nlm.nih.gov/24559314/

[2]Frese, C et al. (2015) Effect of endurance training on dental erosion, caries and saliva. Scandinavian Journal of Medicine and Science in Sports. Vol 3: 319-326 [Available] https://pubmed.ncbi.nlm.nih.gov/24559314/

[3] (Adapted from) Wetherell, J. Richards, L. Sambrook, P. Townsend, G. (2001) Management of acute dental pain: a practical approach for primary health care providers. Australian Prescriber Vol 24: 144-148 [Available] https://www.nps.org.au/australian-prescriber/articles/management-of-acute-dental-pain-a-practical-approach-for-primary-health-care-providers

[4] Johnson, C. Cob, A. Granger, P. Langdana, B. Geddes,D. Oxford Handbook of Expedition and Wilderness Medicine, 2nd edition. Ch 11: 349-350

[5] Bourguignon,C. Cohenca,N. Lauridsen,E. Flores, M T. O'Connell, A C. Day, P F. Tsilingaridis, G. Abbott, P v. Fouad, A F. Hicks, L. Andreason, J o. Cehreli, Z C. Harlamb, s. Kahler, B. Oginni, A. Semper, M. Levin, L. (2020) International Association of Dental Traumatology guidelines for the management of traumatic dental injuries:1. Fractures and luxations. Dental Traumatology. Vol 6, issue 4: 314-330. [Available] https://pubmed.ncbi.nlm.nih.gov/32475015/

[6] Djemal, S. Patel, K. (2018) Management of traumatic dental injuries presenting to the emergency department. Journal of Emergency Medicine and Care. Vol 1 Issue 1: 104.
[Available] http://www.annexpublishers.com/articles/JEMC/1104-Management-of-Traumatic-Dental-Injuries-Presenting-to-the-Emergency-Department.pdf

[7] Langdana, B. Expedition Dentistry Handbook. 13 [Available] https://wildernessdentistry.com/wp-content/uploads/2018/04/Expedition-Dentistry-Workshop-Handbook..pdf

MENTAL HEALTH

[1]Fullam, J., Hunt. H., Lovell, R., Husk.k et al (2021) Nature on Prescription. European Centre for Environment and Human Health, University of Exeter College of Medicine and Health, U.K

[2] Jacoby, R., Barsky, K., Porat, T., Harel, S., Miller.t . and Goldzweig, G (2021) Individual stress response patterns: preliminary findings and possible implications. Public Library of Science (PLoS 1). Vol 16:8

[3] Lyon, R. and Wiggins, C. (2010) 'Expedition medicine – the risk of illness and injury' Wilderness & Environmental Medicine, Vol 4:318-24

[4] Moore, J (2008) Mental Health Issues on Expedition. Wilderness & Environmental Medicine. Vo, 19, Issue 3 pp220-221.

[5] https://www.time-to-change.org.uk/ website accessed January 2023.

[6] Thanks to my colleague Katie Beck from Raleigh International for kindly sharing this unpublished data (WD).

[7] Havighurst SS, Downey L. Clinical Reasoning for Child and Adolescent Mental Health Practitioners: The Mindful Formulation. Clinical Child Psychology and Psychiatry. 2009;14(2):251-271.

[8] Gaebel W, Stricker J, Kerst A. Changes from ICD-10 to ICD-11 and future directions in psychiatric classification . Dialogues Clin Neurosci. 2020 Mar;22(1):7-15. doi: 10.31887/DCNS.2020.22.1/wgaebel. PMID: 32699501; PMCID: PMC7365296.

[9] Coryell, W. (2021) Depressive Disorders. MSD Manual. Online [Available]: www.msdmanuals.com/professional/psychiatric-disorders/mood-disorders/depressive-disorders#v1028038

[10] Depression in adults:treatment and management NICE guideline NG222. Puglished: 29 June 2022.

[11] GMC Good Medical Practice Published 25th March 2013 https://www.gmc-uk.org/-/media/documents/good-medical-practice---english-20200128_pdf-51527435.pdf

[12] Sinclair L, Leach R. Exploring thoughts of suicide BMJ 20176; 356:i1128 doi:10.1136/bmj.j1128

[13] Dieltjens, Tessa & Moonens, Inge & Van Praet, Koen & De Buck, Emmy & Vandekerckhove, Philippe. (2014). A Systematic Literature Search on Psychological First Aid: Lack of Evidence to Develop Guidelines. PloS one. 9. e114714. 10.1371/journal.pone.0114714.

MEDEVAC

[1] Van Zwanenbert, G. Dransfield, M. Juneja, R A consensus to determine the ideal critical care transfer bag. Journal of the Intensive Care Society 0(0) 1–9 (2016)

[2] Provisions for medical evacuation when trekking on kilimanjaro. Pride Expeditions 15 Feb 2019. Link: https://www.prideexpeditions.co.uk/blogs/medicalevacuationonkilimanjaro

[3] Bledsoe G H et al Expedition & Wildnerness Medicine. Cambridge University Press. (2009) pp676-677

[4] Dr John Ferris, BASICS Clinical Guidelines on Patient Packaging, 2015

[5] Greaves, Ian. Porter, Keith. Oxford Handbook of Pre-Hospital Care Flexibound (2021)

EXPEDITION OPHTHALMOLOGY

[1] Morris, D., Mella, S. and Depla, D (2013) Eye problems on expeditions. Travel Medicine and Infectious Disease. Vol 11:152-158

[2] Denniston, A. and Murray, P (2018) Oxford Handbook of Ophthalmology. 4th edition. Oxford University Press.

[3] Joondeph, B (2018) Gas Bubbles and Altitude. Retina Today. Online [Available]: https://retinatoday.com/articles/2018-sept/gas-bubbles-and-altitude

[4] Fromow-Guerra, J,. Meza-de Regil, A., and Solís-Vivanco, A et al (2016) The effect of altitude on intraocular pressure in vitrectomized eyes with sulfur hexafluoride tamponade by the Friedenwald Method: rabbit animal model. BioMed Research International: 7326160.

[5] Lim, H., Turner, A., and Lim, B (2016) Patching for corneal abrasion. Cochrane Database of Systematic Reviews. Vol 7:CD004764

[6] Johnson, C., Anderson, S. and Dallimore, J et al (2015) Oxford handbook of expedition and wilderness medicine. 2nd Edition. Oxford University Press

[7] Kohnen, T (2012) Effects of refractive surgery in extreme altitude or space. Journal of Cataract & Refractive Surgery. Vol 38 (8):1307-1308

[8]Dimmig, J. and Tabin, G (2003). The ascent of Mount Everest following laser in situ keratomileusis. Journal of Refractive Surgery: 19:48-51